

ARIZONA WATER ATLAS

VOLUME 8

ACTIVE MANAGEMENT AREA PLANNING AREA



Arizona Department of Water Resources

DRAFT
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CONTENTS

PREFACE	1
SECTION 8.0	
Overview of the AMA Planning Area	3
8.0.1 Geography	3
8.0.2 Hydrology	6
Groundwater Hydrology	6
Surface Water Hydrology	13
8.0.3 Climate	19
8.0.4 Environmental Conditions	23
Vegetation	23
Arizona Water Protection Fund Programs	28
Instream Flow Claims	28
Threatened and Endangered Species	31
National Parks, Monuments, Wildlife Refuges and Wilderness Areas	31
8.0.5 Population	35
Population Growth and Water Use	37
8.0.6 Water Supply	42
Central Arizona Project Water	43
Surface Water	45
Groundwater	46
Effluent	47
Contamination Sites	48
8.0.7 Cultural Water Demand	50
Tribal Water Demand	53
Municipal Demand	56
Agricultural Demand	63
Industrial Demand	69
8.0.8 Water Resource Issues in the AMA Planning Area	72
8.0.9 AMA Water Resource Characteristics	75
REFERENCES	79
 SECTION 8.1	
Water Resource Characteristics of the Phoenix AMA	85
8.1.1 Geography of the Phoenix AMA	86
8.1.2 Land Ownership in the Phoenix AMA	88
8.1.3 Climate of the Phoenix AMA	91
8.1.4 Surface Water Conditions in the Phoenix AMA	96
8.1.5 Perennial/Intermittent Streams and Springs in the Phoenix AMA	108
8.1.6 Groundwater Conditions of the Phoenix AMA	111
8.1.7 Water Quality Exceedences and Contamination Sites in the Phoenix AMA	132

8.1.8 Cultural Water Demands in the Phoenix AMA	157
8.1.9 Assured Water Supply Determinations in the Phoenix AMA	164
References and Supplemental Reading	198
Index to Section 8.0	204

SECTION 8.2

Water Resource Characteristics of the Pinal AMA	205
8.2.1 Geography of the Pinal AMA	206
8.2.2 Land Ownership in the Pinal AMA	208
8.2.3 Climate of the Pinal AMA	211
8.2.4 Surface Water Conditions in the Pinal AMA	214
8.2.5 Perennial/Intermittent Streams and Springs in the Pinal AMA	219
8.2.6 Groundwater Conditions of the Pinal AMA	222
8.2.7 Water Quality Exceedences and Contamination Sites in the Pinal AMA	237
8.2.8 Cultural Water Demands in the Pinal AMA	247
8.2.9 Assured Water Supply Determinations in the Pinal AMA	252
References and Supplemental Reading	259
Index to Section 8.0	263

SECTION 8.3

Water Resource Characteristics of the Prescott AMA	265
8.3.1 Geography of the Prescott AMA	266
8.3.2 Land Ownership in the Prescott AMA	268
8.3.3 Climate of the Prescott AMA	270
8.3.4 Surface Water Conditions in the Prescott AMA	273
8.3.5 Perennial/Intermittent Streams and Springs in the Prescott AMA	278
8.3.6 Groundwater Conditions of the Prescott AMA	281
8.3.7 Water Quality Exceedences and Contamination Sites in the Prescott AMA	289
8.3.8 Cultural Water Demands in the Prescott AMA	294
8.3.9 Assured Water Supply Determinations in the Prescott AMA	298
References and Supplemental Reading	303
Index to Section 8.0	310

SECTION 8.4

Water Resource Characteristics of the Santa Cruz AMA	311
8.4.1 Geography of the Santa Cruz AMA	312
8.4.2 Land Ownership in the Santa Cruz AMA	314
8.4.3 Climate of the Santa Cruz AMA	316
8.4.4 Surface Water Conditions in the Santa Cruz AMA	319
8.4.5 Perennial/Intermittent Streams and Springs in the Santa Cruz AMA	324
8.4.6 Groundwater Conditions of the Santa Cruz AMA	326
8.4.7 Water Quality Exceedences and Contamination Sites in the Santa Cruz AMA	332

8.4.8 Cultural Water Demands in the Santa Cruz AMA	337
8.4.9 Assured Water Supply Determinations in the Santa Cruz AMA	341
References and Supplemental Reading	345
Index to Section 8.0	349
Section 8.5	
Water Resource Characteristics of the Tucson AMA	351
8.5.1 Geography of the Tucson AMA	352
8.5.2 Land Ownership in the Tucson AMA	354
8.5.3 Climate of the Tucson AMA	357
8.5.4 Surface Water Conditions in the Tucson AMA	360
8.5.5 Perennial/Intermittent Streams and Springs in the Tucson AMA	369
8.5.6 Groundwater Conditions of the Tucson AMA	372
8.5.7 Water Quality Exceedences and Contamination Sites in the Tucson AMA	386
8.5.8 Cultural Water Demands in the Tucson AMA	398
8.5.9 Assured Water Supply Determinations in the Tucson AMA	403
References and Supplemental Reading	416
Index to Section 8.0	422
ACRONYMS AND ABBREVIATIONS	424
APPENDIX A: Arizona Water Protection Fund Projects in the AMA Planning Area through 2005	428
APPENDIX B: Central Arizona Project Subcontracts	432

FIGURES

Figure 8.0-1	Arizona Planning Areas	2
Figure 8.0-2	AMA Planning Area	4
Figure 8.0-3	Arizona physiographic provinces	5
Figure 8.0-4	AMA Planning Area USGS Watersheds	14
Figure 8.0-5	Average monthly temperature from 1952-2007 in the AMA Planning Area	19
Figure 8.0-6	Average monthly precipitation from 1948-1952 to 2006-2007	20
Figure 8.0-7	Annual percent of average precipitation measured between 1960-2007	21
Figure 8.0-8	Average annual temperature measured between 1960 and 2007	22
Figure 8.0-9	Average June, July and August temperature measured between 1960 and 2007	23
Figure 8.0-10	AMA Planning Area Biotic Communities and Ecoregions	25
Figure 8.0-11	AMA Planning Area Location of Major Wildfires 2002-2006	27
Figure 8.0-12	AMA Planning Area Instream Flow Applications	29
Figure 8.0-13	AMA Planning Area Protected Areas	32
Figure 8.0-14	Water supply utilized in the AMA Planning Area	42
Figure 8.0-15	Central Arizona Project system map	43
Figure 8.0-16	AMA Water Demand by Sector and Water Source Avg. 2001-2003	51
Figure 8.0-17	City of Nogales, Arizona water use 1996-2006	62
Figure 8.0-18	Large irrigation districts in the AMA Planning Area	65
Figure 8.0-19	Average agricultural water use in the AMA Planning Area 2001-2003	66
Figure 8.1-1	Phoenix AMA Geographic Features	87
Figure 8.1-2	Phoenix AMA Land Ownership	90
Figure 8.1-3	Phoenix AMA Meteorological Stations and Annual Precipitation	95
Figure 8.1-4A	Phoenix AMA, East Valley Area Surface Water Conditions	106
Figure 8.1-4B	Phoenix AMA, West Valley Area Surface Water Conditions	107
Figure 8.1-5	Phoenix AMA Perennial/Intermittent Streams and Major (>10 gpm) Springs	110
Figure 8.1-6	Phoenix AMA Groundwater Conditions	113
Figure 8.1-6A	East Salt River, Fountain Hills & Carefree Sub-basins Groundwater Conditions	114
Figure 8.1-6B	Hassayampa Sub-basin Groundwater Conditions	115
Figure 8.1-6C	Rainbow Valley Sub-basin Groundwater Conditions	116
Figure 8.1-6D	West Salt River Valley/Lake Pleasant Sub-basins Groundwater Conditions	117
Figure 8.1-7	Phoenix Active Management Area Hydrographs Showing Depth to Water in Selected Wells	118

Figure 8.1-8	Phoenix AMA Well Yields	126
Figure 8.1-9	Phoenix AMA Recharge Sites	131
Figure 8.1-10	Phoenix AMA Water Quality Conditions	148
Figure 8.1-10A	Phoenix AMA Impaired Lakes & Streams	149
Figure 8.1-11	Phoenix AMA Contamination Sites	154
Figure 8.1-11A	Central Phoenix AMA Contamination Sites	155
Figure 8.1-12	Phoenix AMA Cultural Water Demands	163
Figure 8.1-13A	Phoenix AMA East Valley Assured Water Supply Determinations	195
Figure 8.1-13B	Phoenix AMA West Valley Assured Water Supply Determinations	196
Figure 8.2-1	Pinal AMA Geographic Features	207
Figure 8.2-2	Pinal AMA Land Ownership	210
Figure 8.2-3	Pinal AMA Meteorological Stations and Annual Precipitation	213
Figure 8.2-4	Pinal AMA Surface Water Conditions	218
Figure 8.2-5	Pinal AMA Perennial/Intermittent Streams and Major (>10 gpm) Springs	221
Figure 8.2-6	Pinal AMA Groundwater Conditions	224
Figure 8.2-6A	Maricopa-Stanfield/Vekol Valley Sub-basins Groundwater Conditions	225
Figure 8.2-6B	Eloy Sub-basin Groundwater Conditions	226
Figure 8.2-7	Pinal Active Management Area Hydrographs Showing Depth to Water in Selected Wells	227
Figure 8.2-8	Pinal AMA Well Yields	233
Figure 8.2-9	Pinal AMA Recharge Sites	236
Figure 8.2-10	Pinal AMA Water Quality Conditions	243
Figure 8.2-11	Pinal AMA Contamination Sites	246
Figure 8.2-12	Pinal AMA Cultural Water Demand	251
Figure 8.2-13	Pinal AMA Assured Water Supply Determinations	258
Figure 8.3-1	Prescott AMA Geographic Features	267
Figure 8.3-2	Prescott AMA Land Ownership	269
Figure 8.3-3	Prescott AMA Meteorological Stations and Annual Precipitation	272
Figure 8.3-4	Prescott AMA Surface Water Conditions	277
Figure 8.3-5	Prescott AMA Perennial/Intermittent Streams and Major (>10 gpm) Springs	280
Figure 8.3-6	Prescott AMA Groundwater Conditions	283
Figure 8.3-7	Prescott Active Management Area Hydrographs Showing Depth to Water in Selected Wells	284
Figure 8.3-8	Prescott AMA Well Yields	286
Figure 8.3-9	Prescott AMA Recharge Sites	288
Figure 8.3-10	Prescott AMA Water Quality Conditions	291
Figure 8.3-11	Prescott AMA Contamination Sites	293
Figure 8.3-12	Prescott AMA Cultural Water Demand	297

Figure 8.3-13	Prescott AMA Assured Water Supply Determinations	302
Figure 8.4-1	Santa Cruz AMA Geographic Features	313
Figure 8.4-2	Santa Cruz AMA Land Ownership	315
Figure 8.4-3	Santa Cruz AMA Meteorological Stations and Annual Precipitation	318
Figure 8.4-4	Santa Cruz AMA Surface Water Conditions	323
Figure 8.4-5	Santa Cruz AMA Perennial/Intermittent Streams and Major (>10 gpm) Springs	325
Figure 8.4-6	Santa Cruz AMA Groundwater Conditions	328
Figure 8.4-7	Santa Cruz Active Management Area Hydrographs Showing Depth to Water in Selected Wells	329
Figure 8.4-8	Santa Cruz AMA Well Yields	331
Figure 8.4-9	Santa Cruz AMA Water Quality Conditions	334
Figure 8.4-10	Santa Cruz AMA Contamination Sites	336
Figure 8.4-11	Santa Cruz AMA Cultural Water Demand	340
Figure 8.4-12	Santa Cruz AMA Assured Water Supply Determinations	344
Figure 8.5-1	Tucson AMA Geographic Features	353
Figure 8.5-2	Tucson AMA Land Ownership	356
Figure 8.5-3	Tucson AMA Meteorological Stations and Annual Precipitation	359
Figure 8.5-4	Tucson AMA Surface Water Conditions	368
Figure 8.5-5	Tucson AMA Perennial/Intermittent Streams and Major (>10 gpm) Springs	371
Figure 8.5-6	Tucson AMA Groundwater Conditions	374
Figure 8.5-6A	Tucson AMA Avra Valley Sub-basin Groundwater Conditions	375
Figure 8.5-6B	Upper Santa Cruz Sub-basin Groundwater Conditions	376
Figure 8.5-7	Tucson Active Management Area Hydrographs Showing Depth to Water in Selected Wells	378
Figure 8.5-8	Tucson AMA Well Yields	382
Figure 8.5-9	Tucson AMA Recharge Sites	385
Figure 8.5-10	Tucson AMA Water Quality Conditions	392
Figure 8.5-11	Tucson AMA Contamination Sites	397
Figure 8.5-12	Tucson AMA Cultural Water Demand	402
Figure 8.5-13	Tucson AMA Assured Water Supply Determinations	415

TABLES

Table 8.0-1	Instream flow claims in the AMA Planning Area	28
Table 8.0-2	Listed threatened and endangered species in the AMA Planning Area	30
Table 8.0-3	Wilderness areas in the AMA Planning Area	34
Table 8.0-4	2000 Census population of AMAs and Indian reservations	35
Table 8.0-5	Communities in Active Management Areas with a Census population greater than 1,000 (listed by 2000 population)	36
Table 8.0-6	Designated water providers in the AMA Planning Area	39
Table 8.0-7	Assured Water Supply determinations in the AMA Planning Area	41
Table 8.0-8	Contamination sites in the AMA Planning Area	49
Table 8.0-9	AMA water demand by sector and water source (Indian and Non-Indian) avg. 2001-2003	52
Table 8.0-10	Average annual municipal water demand in the AMA Planning Area (2001-2003)	56
Table 8.0-11	Water providers serving a minimum of 1,000 acre-feet of water annually (excluding effluent) in the AMA Planning Area	58
Table 8.0-12	Water Use by Golf Courses in 2006	59
Table 8.0-13	Agricultural demand in the AMA Planning Area excluding Indian demand	64
Table 8.0-14	Industrial demand in selected years in the AMA Planning Area	70
Table 8.1-1	Climate Data for the Phoenix AMA	92
Table 8.1-2	Streamflow Data for the Phoenix AMA	97
Table 8.1-3	Flood ALERT Equipment in the Phoenix AMA	100
Table 8.1-4	Reservoirs and Stockponds in the Phoenix AMA	105
Table 8.1-5	Springs in the Phoenix AMA	109
Table 8.1-6	Groundwater Data for the Phoenix AMA	112
Table 8.1-7	Recharge Sites in the Phoenix AMA	127
Table 8.1-8	Water Quality Exceedences in the Phoenix AMA	133
Table 8.1-9	Contamination Sites in the Phoenix AMA	150
Table 8.1-10	Cultural Water Demands in the Phoenix AMA	158
Table 8.1-11	Effluent Generation in the Phoenix AMA	159
Table 8.1-12	Assured Water Supply Determinations in the Phoenix AMA	165
Table 8.2-1	Climate Data for the Pinal AMA	212
Table 8.2-2	Streamflow Data for the Pinal AMA	215
Table 8.2-3	Flood ALERT Equipment in the Pinal AMA	216
Table 8.2-4	Reservoirs and Stockponds in the Pinal AMA	217
Table 8.2-5	Springs in the Pinal AMA	219
Table 8.2-6	Groundwater Data for the Pinal AMA	223
Table 8.2-7	Recharge Sites in the Pinal AMA	234

Table 8.2-8	Water Quality Exceedences in the Pinal AMA	238
Table 8.2-9	Contamination Sites in the Pinal AMA	244
Table 8.2-10	Cultural Water Demands in the Pinal AMA	248
Table 8.2-11	Effluent Generation in the Pinal AMA	249
Table 8.2-12	Assured Water Supply Determinations in the Pinal AMA	253
Table 8.3-1	Climate Data for the Prescott AMA	271
Table 8.3-2	Streamflow Data for the Prescott AMA	274
Table 8.3-3	Flood ALERT Equipment in the Prescott AMA	275
Table 8.3-4	Reservoirs and Stockponds in the Prescott AMA	276
Table 8.3-5	Springs in the Prescott AMA	279
Table 8.3-6	Groundwater Data for the Prescott AMA	282
Table 8.3-7	Recharge Sites in the Prescott AMA	287
Table 8.3-8	Water Quality Exceedences in the Prescott AMA	290
Table 8.3-9	Contamination Sites in the Prescott AMA	292
Table 8.3-10	Cultural Water Demands in the Prescott AMA	295
Table 8.3-11	Effluent Generation in the Prescott AMA	296
Table 8.3-12	Assured Water Supply Determinations in the Prescott AMA	299
Table 8.4-1	Climate Data for the Santa Cruz AMA	317
Table 8.4-2	Streamflow Data in the Santa Cruz AMA	320
Table 8.4-3	Flood ALERT Equipment in the Santa Cruz AMA	321
Table 8.4-4	Reservoirs and Stockponds in the Santa Cruz AMA	322
Table 8.4-5	Springs in the Santa Cruz AMA	324
Table 8.4-6	Groundwater Data for the Santa Cruz AMA	327
Table 8.4-7	Water Quality Exceedences in the Santa Cruz AMA	333
Table 8.4-8	Contamination Sites in the Santa Cruz AMA	335
Table 8.4-9	Cultural Water Demand in the Santa Cruz AMA	338
Table 8.4-10	Effluent Generation in the Santa Cruz AMA	339
Table 8.4-11	Assured Water Supply Determinations in the Santa Cruz AMA	342
Table 8.5-1	Climate Data for the Tucson AMA	358
Table 8.5-2	Streamflow Data for the Tucson AMA	361
Table 8.5-3	Flood ALERT Equipment in the Tucson AMA	363
Table 8.5-4	Reservoirs and Stockponds in the Tucson AMA	366
Table 8.5-5	Springs in the Tucson AMA	370
Table 8.5-6	Groundwater Data for the Tucson AMA	373
Table 8.5-7	Recharge Sites in the Tucson AMA	383
Table 8.5-8	Water Quality Exceedences in the Tucson AMA	387
Table 8.5-9	Contamination Sites in the Tucson AMA	393
Table 8.5-10	Cultural Water Demands in the Tucson AMA	399
Table 8.5-11	Effluent Generation in the Tucson AMA	400
Table 8.5-12	Assured Water Supply Determinations for the Tucson AMA	404

ARIZONA WATER ATLAS VOLUME 8 –ACTIVE MANAGEMENT AREA PLANNING AREA

Preface

Volume 8, the Active Management Area (AMA) Planning Area, is the eighth in a series of nine volumes that comprise the Arizona Water Atlas. The primary objectives in assembling the Atlas are to present an overview of water supply and demand conditions in Arizona, to provide water resource information for planning and resource development purposes and help to identify the needs of communities.

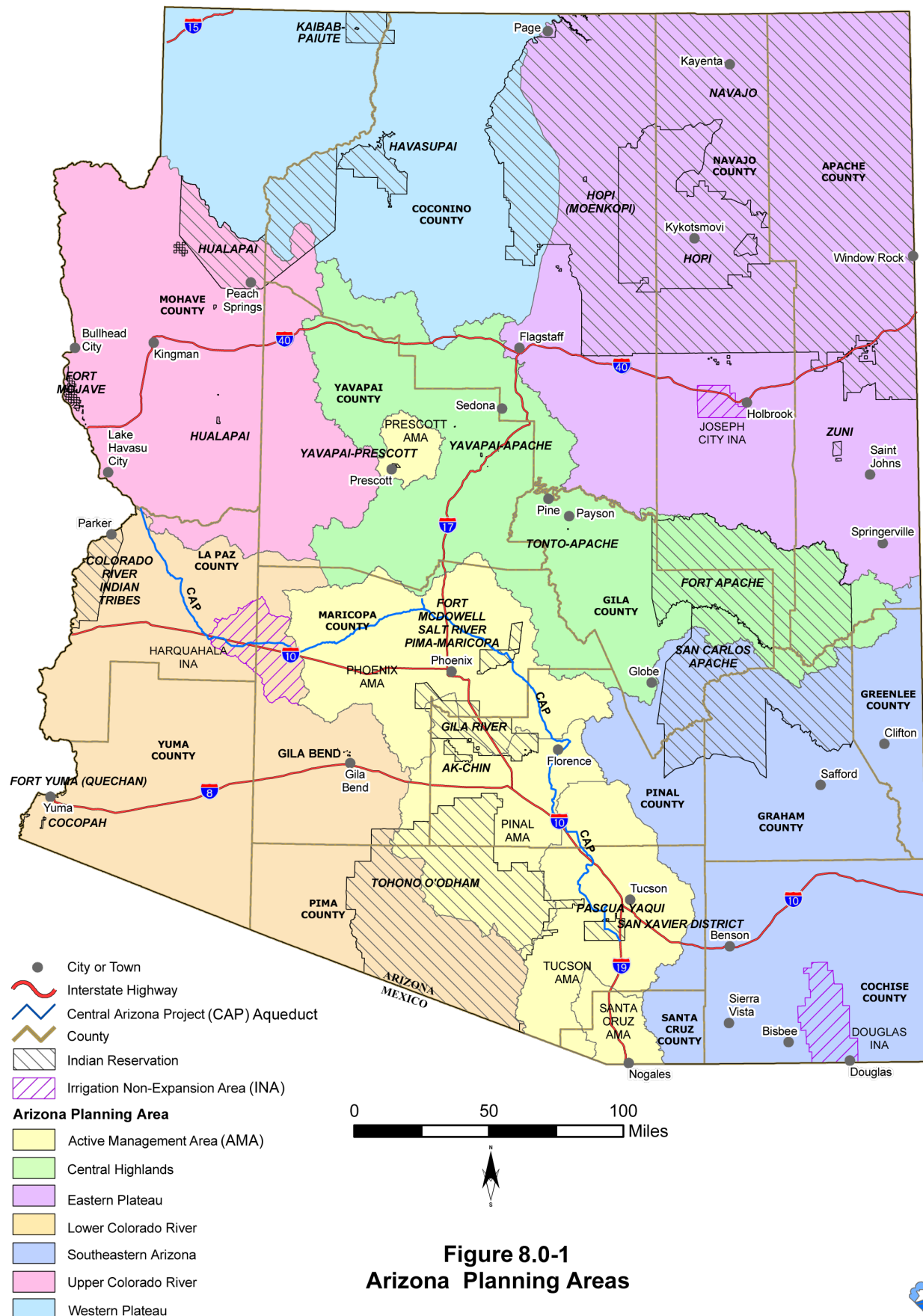
The Atlas divides Arizona into seven planning areas (Figure 8.0-1). There is a separate Atlas volume for each planning area, an introductory/executive summary volume and a resource evaluation volume that examines resource sustainability. “Planning areas” are an organizational concept that provide for a regional perspective on supply, demand and water resource issues. A complete discussion of Atlas organization, purpose and scope is found in Volume 1. Also included in Volume 1 is general background information for the state, a description of data sources and methods of analysis for the tables and maps presented in the Atlas, and appendices that provide information on water law, management and programs, and Indian water rights claims and settlements.

To the maximum extent possible, the organization and content of this volume of the Atlas mirrors the six other planning areas. However, readers should be aware that the overall scope of this document differs in some important ways.

Five AMAs have been designated in the state as requiring specific, mandatory management practices to preserve and protect groundwater supplies for the future. Four AMAs - Phoenix, Pinal, Prescott and Tucson - were established in 1980 upon enactment of the Groundwater Code (Code) (A.R.S. §§ 45-401 et seq.). In 1994, the Arizona legislature established the Santa Cruz AMA, which had previously been the southeast portion of the Tucson AMA. This legislation recognized the international water management issues facing this area, and that its hydrology required coordinated management of surface water and groundwater.

The AMAs include the state’s most urbanized areas, and water use is subject to an extensive regulatory framework. As a result, water supply and demand data within AMAs is often more detailed and comprehensive than outside the AMAs, and unique legal and regulatory complexities exist. By adhering to the standardized Atlas format, Volume 8 provides an important overview of the AMAs and allows for direct comparison with the rest of the state. However, this volume does not include extensive data analysis, nor is it intended to be a comprehensive compilation of information relevant to the AMAs.

This volume of the Atlas is the first document of a larger AMA planning effort that includes the AMA Assessment and the fourth management plan for each AMA. The AMA Assessment includes a compilation of historic data, including detailed water budgets; future scenario development; and issue identification, notably issues related to achievement of the statutory management goals for each AMA. The AMA Assessment is intended to provide an analytical foundation for the



development and promulgation of Fourth Management Plans (A.R.S. §§ 45-561 et seq.). The Management Plans include mandatory regulatory provisions that apply to each water use sector within an AMA. These provisions do not apply to tribal users.

There are additional, more detailed data available to those presented in this volume. These data may be obtained by contacting the Arizona Department of Water Resources (Department).

8.0 Overview of the AMA Planning Area

The AMA Planning Area is composed of five groundwater basins located in the central and south central parts of the state. The AMAs were established pursuant to the 1980 Groundwater Management Act. The basins are designated as the Santa Cruz AMA, the Tucson AMA, the Pinal AMA, the Phoenix AMA, and the Prescott AMA. The AMAs are located in portions of Santa Cruz, Pima, Pinal, and Maricopa counties as well as the central portion of Yavapai County. There are seven Indian reservations within the planning area including the Tohono O'odham Nation (consisting of three reservations in the planning area), Pascua Yaqui Tribe, Ak-Chin Indian Community, Gila River Indian Community, Fort McDowell Yavapai Nation, Salt River Pima-Maricopa Indian Community, and the Yavapai-Prescott Indian Tribe.

In 2006, just over 80% of the state's 6.2 million inhabitants lived in the planning area. In 2003, AMA populations ranged from approximately 38,000 residents in the Santa Cruz AMA to over 3,400,000 residents in the Phoenix AMA. The Arizona Department of Economic Security (DES) estimates that the state's population will likely double by 2050 to over 12 million people. The majority of this growth will occur in the AMA Planning Area.





Between 2001-2003 an average of 3.7 million acre-feet (maf) of water was used annually in the planning area for agricultural, municipal and industrial purposes (including Indian water demands). Of this total demand, approximately 45% was met with groundwater supplies, 30% was met with Central Arizona Project (CAP) water, 20% was met with surface water and 5% was met with effluent or reclaimed water. Agriculture is the largest use sector in the planning area with an average annual demand of approximately 2.2 maf or 60% of the total planning area demand. Municipal sector demand is about 1.3 maf (34%) and industrial sector demand is about 0.23 maf (6%).

8.0.1 Geography

The AMA Planning Area covers approximately 14,700 square miles and stretches continuously from the international border through central Arizona to the northern boundary of Maricopa County. The most northern AMA, the Prescott AMA, is discontinuous from the other four AMAs (Figure 8.0-2). The Prescott AMA is within the boundaries of the Central Highlands Planning Area, which borders the Phoenix AMA on the north. The planning area is located between the Southeastern Arizona Planning Area on the east and the Lower Colorado River Planning Area on the west and includes portions of six watersheds, which are discussed in section 8.0-2, Surface Water Hydrology.

Most of the AMA Planning Area is located in the Basin and Range physiographic province, which

**Figure 8.0-2
AMA
Planning Area**

International Boundary 
Basin Boundary 
COUNTY 
City, Town or Place 



is characterized by broad, gently sloping alluvial basins separated by north to northwest trending fault-block mountains. The Prescott AMA and a small portion of the Phoenix AMA lie within the Central Highlands transition zone, which is characterized by a narrow band of mountains of igneous, metamorphic, and sedimentary rocks (Figure 8.0-3). Because of its geographic extent and location in the state, the planning area exhibits a wide range of geographic features, from low elevation, broad, semi-arid Sonoran desert valleys to mountain ranges with summits over 9,000 feet. The topographic variability results in broad variations in the amount of precipitation, temperature range and vegetation type.



Figure 8.0-3 Arizona physiographic provinces

At approximately 485 square miles in area, the Prescott AMA is the smallest AMA basin and has the highest average elevation. Elevations range from 4,400 feet in the valleys to approximately 7,800 feet in the Bradshaw Mountains. The AMA is characterized by rolling topography, broad sloping alluvial basins and fault block mountains (see Figure 8.3-1). Surface drainages are primarily ephemeral or intermittent.

The Santa Cruz AMA is approximately 716 square miles in area and is the southernmost AMA. It lies adjacent to the international border and its major drainage, the Santa Cruz River, flows from Mexico into the basin. The AMA is characterized by the relatively narrow river drainage flanked by hills and higher elevation mountains on its northern, eastern and western boundaries. Elevations range from 3,000 feet where the Santa Cruz River exits the basin to over 9,400 feet in the Santa Rita Mountains (see Figure 8.4-1).

North and west of the Santa Cruz AMA, the Tucson AMA is approximately 3,866 square miles in area with two major, parallel alluvial valleys, the Upper Santa Cruz in the east and the Avra and Altar Valleys in the west. High elevation mountain ranges form the eastern and southern borders of the AMA. These “sky islands” are relatively isolated ranges separated by valleys that are part of a unique complex of mountain ranges that are also found in northern Mexico and New Mexico (Warshall, 2006). The Santa Cruz River drains the Upper Santa Cruz Valley and is the major drainage in the AMA. The Tucson AMA has the widest elevational range of any of the AMAs with elevations ranging from 1,770 feet north of Picacho Peak, to over 9,400 feet in the Santa Rita Mountains (see Figure 8.5-1).

The Pinal AMA is located to the north and west of the Tucson AMA, and at 4,100 square miles in area is the second largest basin in the planning area. It is characterized by broad, alluvial Sonoran desert valleys and mid-elevation north to northwest trending fault-block mountains. The AMA is semi-arid with average precipitation of less than 8 inches a year in most of the basin. The Gila River flows east to west in the northern part of the basin while the Santa Cruz River enters the basin from the southeast, flowing primarily ephemerally toward the northwest. Elevations range from about 1,000 feet where the Gila River and Santa Cruz River exit the basin in the northwest to over 6,800 feet at Kitt Peak at the southern basin boundary (see Figure 8.2-1).

The Phoenix AMA is the largest AMA basin at approximately 5,646 square miles and is characterized by Sonoran desert valleys that are generally from 1,000 to 2,500 feet above mean sea level, surrounded by mid-elevation mountain ranges. The basin is drained by five major rivers, the Salt, Gila, Verde, Agua Fria and the Hassayampa. While the basin is semi-arid, generally receiving less than eight inches of precipitation a year, the state's most important water producing watersheds, the Salt and the Verde, converge in the Phoenix AMA, representing an important water supply for the area. Elevation ranges from 755 feet where the Gila River exits the basin to almost 5,900 feet in the New River Mountains on the northern basin boundary (see Figure 8.1-1).

8.0.2 Hydrology¹

Groundwater Hydrology

With the exception of the Prescott AMA, a large portion of the AMA planning area is located in what Anderson, et al. (1992) categorized as the Central basins. Stream alluvial deposits and upper basin fill are the principal water bearing sediments in these basins. The Central basins are characterized by small to moderate amounts of mountain-front recharge, streamflow infiltration and significant underflow in and out of the basins. Groundwater flows tend to move inward from the edges of the basin and higher elevations and then downstream towards the outflow portion of the basin.

The Prescott AMA is located in what Anderson, et al. (1992) categorized as the Highland basins. Highland basins consist of basin fill and alluvium deposits, similar to the Central basins; however, due to their discontinuous nature, little or no underflow occurs between basins. Recharge occurs from surrounding consolidated rock and inflow from stream infiltration.

The central AMAs (Phoenix, Pinal and Tucson) contain deep alluvial aquifers and significant volumes of water in storage. However, since aquifer recharge rates are relatively low and pumping volumes are large, the aquifers have been in an overdraft condition. Within an AMA, overdraft is a condition where groundwater is pumped in excess of safe-yield. The definition of safe-yield is, "to achieve and thereafter maintain a long-term balance between the annual amount of groundwater withdrawn in an active management area and the annual amount of natural and artificial groundwater in an active management area." A.R.S. § 45-561(12). The Prescott AMA aquifers are more discontinuous and less extensive than the large basin fill aquifers of the central

¹ Except as noted, much of the information in this section is taken from the Arizona Water Resources Assessment, Volume II, 1994 and the Third Management Plans for the Active Management Areas (ADWR, 1999).

AMAs. As with the central AMAs, the Prescott AMA is in an overdraft condition. In the Santa Cruz AMA there is a close interrelationship between water levels in the stream alluvium along the Santa Cruz River, and precipitation and drought events. The Santa Cruz AMA is currently in a safe-yield condition.

All of the AMAs, with the exception of the Santa Cruz AMA, contain sub-basins: two in the Prescott AMA, seven in the Phoenix AMA, five in the Pinal AMA, and two in the Tucson AMA. Characteristics of each sub-basin are described individually below.

Central Basins

Phoenix AMA

There are seven groundwater sub-basins in the Phoenix AMA: East Salt River Valley, West Salt River Valley, Hassayampa, Rainbow Valley, Fountain Hills, Lake Pleasant, and Carefree. Each sub-basin has its own unique hydrogeologic characteristics. The primary source of groundwater in the AMA is basin fill sediments. Three distinct water bearing units are identified in most of the sub-basins: an upper alluvial unit, a middle fine-grained unit, and a lower conglomerate unit. Although conditions and circumstances vary across the AMA, most groundwater is pumped from the middle unit. Bedrock, consisting of metamorphic and igneous rock, underlies the basin fill sediments and is not considered to be an aquifer. Well yields throughout the AMA are generally high, with median well yields of over 1,400 gpm reported (Table 8.1-6).

Groundwater quality is generally suitable for most uses, but 35 groundwater contamination sites associated with industrial and other activities have been identified in the AMA. Volatile Organic Compounds (VOCs) are the most common contaminant at these sites. Over 1,500 measurements have been made of parameter concentrations that have equaled or exceeded drinking water standards. Of these, nitrate, fluoride, arsenic, manganese and organics are reportedly the most common. All water providers in Arizona that serve more than 25 people or having 15 or more connections are regulated under the Safe Drinking Water Act and treat water supplies to meet drinking water standards. Detailed information on groundwater quality in the Phoenix AMA is found in the 1999 Third Management Plan, and in Volume II of the 1994 Arizona Water Resources Assessment.

The East Salt River Valley Sub-basin encompasses the eastern part of the AMA and includes a portion of the City of Phoenix, the cities of Scottsdale, Tempe, Mesa, and Chandler, and the towns of Superior, Apache Junction, Gilbert and Queen Creek. Basin fill sediments extend from less than 100 feet near the basin edges to over 10,000 feet southeast of Gilbert, while the middle unit ranges in thickness from less than 100 feet to over 1,800 feet southeast of Gilbert. Groundwater flows into the sub-basin from the Lake Pleasant Sub-basin, the Eloy Sub-basin in the Pinal AMA, and between the Santan and Sacaton mountains in the southern part of the sub-basin. Groundwater also flows toward a cone of depression caused by groundwater pumping east of Chandler (see Figure 8.1-6). ADWR (1991) estimated the volume of groundwater in storage at 66 maf to a depth of 1,200 feet below land surface (bls). Natural groundwater recharge occurs along stream channels and from mountain front recharge. Substantial water level rises were measured between 1991-1992 and 2002-2003 in several wells in the sub-basin (see Figure 8.1-6A). Increases of over 60 feet were reported in some areas due to a combination of cessation of farming and associated reduction in

pumping, and direct use and recharge of CAP water. Groundwater level depths measured during 2002-2003 ranged from ten feet bls near Superior to over 800 feet bls south of Cave Creek.

The West Salt River Valley Sub-basin includes the communities of Phoenix, Buckeye, Surprise, Glendale, Peoria, Goodyear, Tolleson and Avondale. It is a broad, gently-sloping alluvial plain bounded by hills and low-elevation mountains with a depth to bedrock of over 10,000 feet beneath the Luke Air Force Base area. A large salt body lies southeast of Luke Air Force Base at a depth of 880 feet to over 6,000 feet, which locally affects groundwater salinity. The middle alluvial unit ranges in thickness from less than 100 feet to over 1,300 feet southwest of Glendale. ADWR (1991) estimated the volume of water storage in the sub-basin was 59 maf to a depth of 1,200 feet. Natural groundwater recharge occurs along stream channels from mountain front recharge. Groundwater also enters the sub-basin from the Lake Pleasant, northern Hassayampa and East Salt River Valley sub-basins, and from the Maricopa-Stanfield Sub-basin in the Pinal AMA. Groundwater flow historically was toward and along the Salt and Gila Rivers. A cone of depression has formed in the vicinity of Sun City and Litchfield Park where water level declines of more than 300 feet in the area of Luke Air Force Base resulted in surface subsidence of more than 18 feet by 1991 (see Figure 8.1-6) (ADWR, 1996). While groundwater levels rose in that part of the sub-basin between 1991-1992 and 2002-2003, they declined in the Glendale/Goodyear/Phoenix area. Depths to groundwater vary widely in the sub-basin with shallower levels present south of I-10 along the Salt and Gila River drainage (Figure 8.1-6D).

The Hassayampa Sub-basin consists of the largely undeveloped Hassayampa Plain in the north and the lower Hassayampa area in the south. The sub-basin is bounded by hills and mountains and drained by the ephemeral Hassayampa River. There is little geologic data for the northern part of the sub-basin so the basin fill sequence is not well understood. However, depths to bedrock beneath the alluvial plain range from a few tens of feet near the basin margins to over 1,200 feet near the sub-basin center. The lower Hassayampa includes the Tonopah Desert and Centennial Wash area where the depth to bedrock is over 1,200 feet at its center. Groundwater enters the Hassayampa Plain from the northeast and groundwater flow is south toward the Gila River. Groundwater historically flowed into the sub-basin from the West Salt River Valley Sub-basin, but is intermittently interrupted due to groundwater pumping in the West Salt River Valley. Sources of groundwater recharge include streambed (Gila and Hassayampa rivers) infiltration and mountain front recharge. The sub-basin has experienced groundwater level rises in several areas while primarily modest declines have been observed near Tonopah and at other locations throughout the sub-basin. Cones of depression exist in Tonopah and south of Tonopah in the Centennial Wash area (see Figure 8.1-6). Depth to groundwater range from about 20 feet bls in the southwest to over 600 feet bls in the northern part of the sub-basin (Figure 8.1-6B).

The Rainbow Valley Sub-basin is an undeveloped alluvial plain located in the southern part of the AMA and drained by Waterman Wash, an ephemeral stream that joins the Gila River near Buckeye. Depths to bedrock may be greater than 9,600 feet in the center of the sub-basin. The basin fill sequence consists of poorly sorted gravel, sand, silt and clay. Recharge includes streambed infiltration along Waterman Wash and mountain front recharge. Groundwater flow is from south to north and may have historically entered the sub-basin from the Maricopa-Stanfield Sub-basin in the Pinal AMA. Groundwater levels generally declined between 1991-1992 and 2002-2003.

Depths to groundwater measured in 2002-2003 ranged from 140 feet bls to almost 500 feet bls (Figure 8.1-6C).

The Fountain Hills Sub-basin is an extensively dissected alluvial plain bounded by mountains. It is drained by the lower Verde River, which is perennial along the axis of the sub-basin, and by the Salt River in the southern part of the sub-basin. The two rivers converge in the southern portion of the sub-basin. The regional aquifer consists of an older basin fill sequence and unconsolidated alluvium deposited by and hydraulically connected to the Verde River. The depth to bedrock may exceed 4,800 feet. The general groundwater flow direction is from north to south, parallel to the sub-basin axis. The regional aquifer may not be connected to adjacent sub-basins. Groundwater recharge occurs through streambed (Verde and Salt rivers) infiltration and from mountain front recharge. Groundwater levels rose in a number of wells in the sub-basin between 1991-1992 and 2002-2003 while depth to groundwater ranged from 51 feet bls to over 500 feet bls (see Figure 8.1-6A).

The Lake Pleasant Sub-basin is a relatively small, gently sloping alluvial plain surrounded by hills and mountains in the northern part of the AMA. It is drained by the lower Agua Fria River, by New River and by Skunk Creek. Depths to bedrock exceed 800 feet near the center of the sub-basin and the basin fill locally may include interbedded basalt. Reported well yields are generally between 100 and 500 gpm. In the New River area, the local aquifer consists of fractured schist and gneiss and the groundwater supply is drought-sensitive. Well yields in this area are relatively low. Groundwater recharge includes streambed infiltration and mountain front recharge. Groundwater flow is generally from north to south and into the West Salt River Valley and East Salt River Valley sub-basins. Groundwater levels were stable or rose in most measured wells between 1991-1992 and 2002-2003. Depths to water ranged from 17 feet bls to almost 300 feet bls in 2002-2003. (see Figure 8.1-6D)

The Carefree Sub-basin, located in the northeastern part of the AMA, contains a small northwest-trending alluvial plain in the southern part of the sub-basin that is groundwater-bearing. The sub-basin is drained by Cave Creek, a small ephemeral stream. The basin fill in the Carefree Sub-basin is relatively thin (up to 2,000 feet thick) and composed of older, partially-consolidated to consolidated sedimentary rocks. The primary aquifer is the Carefree Formation consisting of alluvial fan and playa deposits and underlain by volcanic rocks. The Grapevine Member is the only significant source of groundwater in this formation and reaches a maximum thickness of 1,300 feet (ADWR, 1991). ADWR (1994) estimated that the volume of groundwater in storage in the Carefree Sub-basin was 570,000 acre-feet to a depth of 1,200 feet bls. Natural groundwater recharge is from mountain front recharge and infiltration of streamflow along Cave Creek. Groundwater flow is generally to the west-southwest. Groundwater levels began declining in the early 1960s, but rose in several wells between 1991-1992 to 2002-2003 as many local golf courses converted from solely groundwater to a combination of CAP water, groundwater and effluent. Depth to water in wells measured in 2002-2003 ranged from 27 feet bls to 330 feet bls. Well yields vary with yields east of Carefree in excess of 1,000 gpm (Figure 8.1-8).

Pinal AMA

The Pinal AMA consists of five sub-basins with unique groundwater underflow, storage, and surface water characteristics. These sub-basins include the Maricopa-Stanfield, Eloy, Vekol Valley, Santa

Rosa Valley, and Aguirre Valley. Sub-basin boundaries follow surface water topographic divides, and in the case of the Eloy and Maricopa-Stanfield sub-basins, a groundwater divide. Groundwater underflow between these two sub-basins is limited or non-existent. Most groundwater development has occurred within the Maricopa-Stanfield and Eloy sub-basins while relatively little development and hydrologic information is available for the Vekol Valley, Santa Rosa Valley and Aguirre Valley sub-basins.

The best groundwater-bearing materials in the Maricopa-Stanfield and Eloy sub-basins consist of the unconsolidated sands, gravels, silts, and clays that were deposited by the ancestral Gila and Santa Cruz rivers. Natural recharge is primarily from streambed infiltration along the Gila and Santa Cruz rivers, which produce relatively large volumes of runoff from upstream basins outside the AMA following heavy rains. Lesser amounts of natural recharge occur from mountain fronts. The estimated groundwater in storage in the two sub-basins is about 31.2 maf with another 4 maf of storage in the Vekol Valley Sub-basin. Median well yield is approximately 1,000 gpm. (see Table 8.2-6)

Demand for water by irrigated agriculture has drained a large portion of the Upper Alluvial Unit in both sub-basins and changed the direction of groundwater flow between sub-basins. In the Maricopa-Stanfield Sub-basin, groundwater flow is north toward the Gila River and toward cones of depression that have formed west of both Maricopa and Stanfield (see Figure 8.2-6). However, groundwater levels are now recovering and rising in much of the sub-basin due to use of CAP water in lieu of groundwater pumping. Water level rises of more than 60 feet were observed in many wells between 1993-1994 and 2003-2004 (Figure 8.2-6). Depths to groundwater range from 51 feet bls near the Gila River in the north to more than 600 feet bls in the vicinity of Stanfield (Figure 8.2-6A).

In the Eloy Sub-basin, groundwater flow is generally to the north toward the Gila River and Phoenix AMA. Reductions in groundwater pumping and use of CAP water have contributed to rising water levels in several wells in this sub-basin. However, groundwater levels are also declining in the north due to dissipation of a groundwater mound formed after Gila River flooding; and in the south central sub-basin, probably from deep well pumping (see Figure 8.2-6). Depth to groundwater ranges from 53 feet bls in the northeast to over 400 feet bls near Picacho (Figure 8.2-6B).

Water quality in the Pinal AMA generally meets state and federal drinking water standards, however exceedences of nitrate, fluoride, arsenic and to a lesser extent, other constituents have been measured at some locations (see Table 8.2-8). Pesticide, jet-fuel and hydraulic fluid contamination is found at several contamination sites in the AMA (Table 8.2-9 and Figure 8.2-11).

Santa Cruz AMA

Basin fill sediments along the Santa Cruz River east and north of the City of Nogales to Amado form three aquifer units. Listed in ascending order, they are the Nogales Formation, the Older Alluvium, and the Younger Alluvium (also referred to as the stream alluvium). Both alluvial units are generally unconfined, hydraulically connected, and yield water to wells, although the Older Alluvium aquifer exhibits semi-confined and confined conditions in some places, most notably in Potrero Creek. The Nogales Formation is not generally considered an important aquifer, although local exceptions may occur. The Older Alluvium varies in thickness from a few feet along the

mountains to more than 1,000 feet in the north-central part of the basin. It exhibits relatively low transmissivity and well yields are often low in wells drilled in this aquifer. The Younger Alluvium forms the most productive and most widely utilized aquifer in the AMA with well yields in excess of 1,000 gpm common. The Younger Alluvium ranges from about 40 to 150 feet thick, becoming thicker and wider to the north along the Santa Cruz River. Groundwater storage in the Younger Alluvium has been estimated at about 160,000 acre-feet. Water levels have generally declined in wells measured in 1995 and 2004-2005 throughout the AMA, with most declines totaling from 1 to 15 feet (see Figure 8.4-6). However, a characteristic of the Younger Alluvium in the Santa Cruz AMA is the potential for rapid water level fluctuations.

Natural groundwater recharge occurs from infiltration of Santa Cruz River channel flow and mountain front recharge. Groundwater inflow enters the basin along the Santa Cruz River and west of Nogales. Groundwater flow is then generally south to north. Groundwater quality is generally good, although arsenic concentrations exceeding the safe drinking water standard have been measured at some wells in the basin. In addition, there are two sites near Nogales with VOC and chromium contamination (see Table 8.4-7 and Figure 8.4-9).

Tucson AMA

The Tucson AMA contains two parallel sub-basins. The Upper Santa Cruz Valley Sub-basin is located in the eastern half of the AMA and the Avra Valley Sub-basin is located in the western half. The sub-basins consist of deep alluvial basins filled with layers of sediments and surrounded by mountains. These sediments contain substantial volumes of groundwater, but the composition and productivity of the sediment layers differ between the two sub-basins.

In the center of the Upper Santa Cruz Valley Sub-basin, the depth to bedrock is in excess of 11,000 feet. Alluvial sediments in this sub-basin have been divided into four hydrogeologic units that form the main regional aquifer and are hydrologically connected to varying degrees. In descending order these units are the recent alluvial deposits, Fort Lowell Formation, Tinaja Beds and Pantano Formation. A basement unit underlies the sediments, forming a relatively impermeable bedrock floor that extends to the surrounding mountains.

The recent alluvial deposits occupy streambed channels of the Santa Cruz River and its major tributaries and are generally less than 100 feet thick. The Fort Lowell Formation consists of unconsolidated to moderately consolidated sands and silts that are 300 to 400 feet thick throughout the sub-basin. The underlying Tinaja Beds are up to 5,000 feet thick in the center of the sub-basin and consist of sandstones, conglomerates, siltstones and mudstones. The Tinaja Beds have become the principal supply of groundwater in the Tucson AMA due to widespread dewatering of the overlying Fort Lowell Formation. Beneath the Tinaja Beds, the Pantano Formation, composed of consolidated sandstones, conglomerates and mudstones, is little used as a water supply because of its depth and relative low well yields. Groundwater flow is from the mountains toward the center of the basin and then north-northwest and north from the Santa Cruz AMA.

The Avra Valley Sub-basin is composed of upper and lower alluvial units. The upper unit is the primary water producing unit in the sub-basin. Composed of silt and gravel, it includes the streambed deposits along Altar and Brawley washes and ranges in thickness from less than 100 feet to more than 1,000 feet. The lower alluvial unit consists of gravel and conglomerates at the edges of the

valley, grading to silts and mudstones along the central axis of the sub-basin. Groundwater flow is from the south to north.

Natural recharge is from mountain front and stream channel (Santa Cruz River) recharge and from groundwater inflow from the Santa Cruz AMA. About 84% of the total net natural recharge in the basin occurs within the Upper Santa Cruz Valley Sub-basin. Estimates of groundwater in storage for the Tucson AMA during predevelopment times ranges from 68 maf to 76 maf (ADWR, 2006a).

As shown in Figure 8.5-8, well yields in excess of 1,000 gpm are found in the vicinity of Sahuarita and Green Valley, near Marana and north of Three Points. Water level rises have been recorded in the last ten years in the northern half of the Avra Valley Sub-basin due to agricultural retirement, use of CAP water in lieu of groundwater pumping and groundwater recharge activities (see Figure 8.5-6A). Similar widespread water level rises have not been noted in the Upper Santa Cruz Sub-basin with the exception of an area north of Sahuarita where CAP water is being recharged at the Pima Mine Road Underground Storage Facility. Elsewhere in the sub-basin, water levels have generally decreased (see Figure 8.5-6B).

Water quality in the Tucson AMA is suitable for most uses, although 47 federally recognized groundwater contamination sites have been identified; elevated concentrations of certain natural constituents, including arsenic, fluoride and metals, are measured in wells. Also, nitrate, sulfate and total dissolved solid concentrations that exceed standards have been detected in wells near mining and agricultural operations. Volatile organic compounds (VOCs) associated with industrial and transportation activities are common at the contamination sites (See Table 8.5-9).

Highlands Basins

Prescott AMA

The Prescott AMA consists of two sub-basins, the Little Chino in the north and the Upper Agua Fria in the south. The sub-basins are separated by a surface drainage divide. Prescott AMA aquifers are discontinuous, with the major aquifer found in a deep structural trough that extends 25 miles from near Dewey-Humboldt to near Del Rio Springs. The trough appears to have formed from basin-and-range faulting and warping and was gradually filled with alluvial, sedimentary, and volcanic rocks of Quarternary to upper Tertiary age.

Three hydrogeologic units have been identified in the AMA. In ascending order they are the Basement Unit, the Lower Volcanic Unit, and the Upper Alluvial Unit. The relatively impermeable Basement Unit is composed of igneous and metamorphic rocks that form the floor and sides of the groundwater sub-basins and is exposed at land surface in the surrounding mountains. The Basement Unit has limited groundwater storage and production capacity and is not regarded as an aquifer except for domestic purposes. ADWR (2005) estimated that there was 2.9 maf of groundwater in storage in the AMA.

The Lower Volcanic Unit overlies the Basement Unit in most of the Little Chino Sub-basin. It is composed of a thick sequence of basaltic and andesitic lava flows interbedded with layers of pyroclastic and alluvial material. The productive thickness of this unit is estimated to range

from less than 100 feet up to several hundred feet. The Lower Volcanic Unit forms a highly productive confined (artesian) aquifer with discharge points northwest of and at Del Rio Springs. Natural recharge to the Lower Volcanic Unit aquifer occurs mainly through infiltration of runoff in ephemeral stream channels and along the mountain fronts of the Little Chino Sub-basin.

The Upper Alluvial Unit occurs as relatively thick sedimentary and volcanic rocks that fill a deep structural trough that extends across both sub-basins. This unit constitutes the main, unconfined aquifer in the Prescott AMA. Natural recharge to this unit is from streambed infiltration and mountain front recharge. The thickness of the unit varies considerably. In the Upper Agua Fria Sub-basin it varies from 800-1,200 feet near Prescott Valley to 200-400 feet near Dewey-Humboldt. In the Little Chino Sub-basin, the thickness of the basin fill is difficult to determine but is estimated to be about 700 feet thick near Del Rio Springs with a median thickness of about 450 feet (Blasch et al., 2006). The combined thickness of the Upper Alluvial Unit and Lower Volcanic Unit is greatest in the central and southeastern portions of the sub-basin.

Groundwater flows generally from the mountain fronts toward the valleys, then north from the Little Chino Sub-basin and south from the Upper Agua Fria Sub-basin. Between 1993-1994 and 2004, water levels declined in most measured wells (Figure 8.3-6). Depths to groundwater in wells ranged from 16 feet bls near Del Rio Springs to almost 500 feet bls in the east-central part of the basin. Well yields are generally between 500 gpm and 1,000 gpm in measured wells in the vicinity of Chino Valley, and between 100 gpm to 500 gpm in the Upper Agua Fria Sub-basin. The median reported well yield among 78 wells with a diameter greater than 10 inches was 763 gpm (Table 8.3-6).

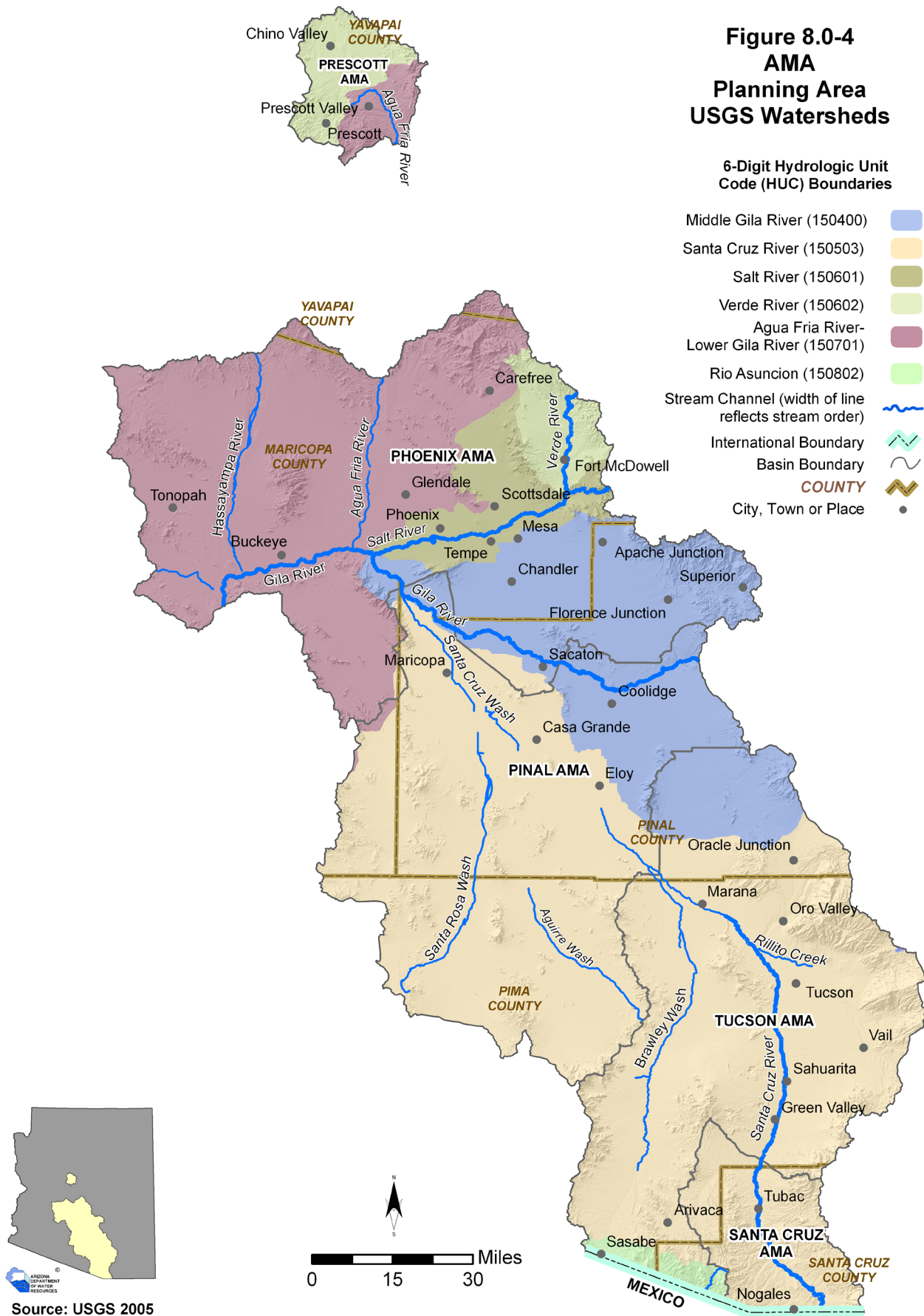
Water quality is generally good; however arsenic, and to a lesser extent other constituents at concentrations exceeding the safe drinking water standards, are found at a number of locations (Table 8.3-8). Sites contaminated with hydrocarbons, lead, cyanide and other contaminants are found near Prescott, Chino Valley and Dewey-Humboldt (see Figure 8.3-11).

Surface Water Hydrology

The U.S. Geological Survey (USGS) divides the United States into successively smaller hydrologic units based on hydrologic features. These units are classified into four descending levels. From largest to smallest they are: regions, subregions, accounting units and cataloging units. Each hydrologic unit is identified by a hydrologic unit code (HUC) consisting of two to eight digits depending on the unit level. A 6-digit code corresponds to accounting units, which are used by the USGS for designing and managing the National Water Data Network.

The AMA planning area encompasses portions of six watersheds at the accounting unit level: the Verde River, the Agua Fria River-Lower Gila River, the Salt River, the Middle Gila River, the Santa Cruz River and the Rio Asuncion (Figure 8.0-4). More detailed information on stream flow gages, springs, reservoirs and general surface water characteristics are found in the individual AMA sections.

**Figure 8.0-4
AMA
Planning Area
USGS Watersheds**



Verde River

The 6,100 square mile Verde River Watershed is located in north-central Arizona. A large part of the watershed is located in the Verde River groundwater basin (See Volume 5, Figure 5.0-3). The northern portion of the watershed begins near Seligman with tributaries of Big Chino Wash. The Verde River is perennial and travels almost 140 miles starting from Sullivan Lake Dam just north of the Prescott AMA, eastward to Perkinsville, southeastward to Fossil Creek, then southward through two reservoirs, (Horseshoe and Bartlett), to its confluence with the Salt River. The last 25 miles of the Verde River, and the southernmost part of the watershed are located in the Phoenix AMA. The Verde River enters the AMA in the north Fountain Hills Sub-basin and moves southward where it joins the Salt River between Stewart Mountain Dam and Granite Reef Diversion Dam. The Verde River is regulated by Horseshoe Dam and Bartlett Dam outside the Phoenix AMA, both of which are part of the Salt River Project (SRP). The SRP is composed of two entities that provide water and power to the Phoenix metropolitan area. One of the entities, the Salt River Valley Water Users Association is a private corporation that delivers nearly one maf of water annually to the Phoenix area through an extensive water delivery system that includes reservoirs, wells, canals and irrigation laterals.

The northwestern portion of the Prescott AMA, the Little Chino Sub-basin, is also located in the Verde River watershed. Granite Creek and Willow Creek comprise the major tributaries that drain the Little Chino Sub-basin into the Verde River. An estimated 14% of the base flow in the Verde River comes from the Little Chino Sub-basin (Wirt, 2005). Dams were constructed on both Granite Creek and Willow Creek, forming Watson Lake and Willow Lake respectively, to store water for diversion to the Chino Valley Irrigation District (CVID). The lakes are now used by the City of Prescott for recreation and municipal water use. During periods of prolonged flooding, flows from these lakes join at the confluence of Granite and Willow Creeks, and then flow northward to join the Verde River near Paulden outside the AMA (see Figure 8.3-4). Little Chino Creek and Big Draw Creek drain the northwestern part of the Little Chino Sub-basin. Little Chino Creek drains the CVID area and flows into the Del Rio Springs area where groundwater naturally discharges at the surface.

Del Rio Springs, located in the northern part of the Prescott AMA, is the only large spring in the AMA with a discharge of 874 gpm measured in 1999. In this area, spring discharge provides essentially permanent baseflow conditions below the springs. The only other major spring in this part of the watershed is Camp Spring northeast of Carefree in the Phoenix AMA with a discharge of about 75 gpm. Sycamore Creek, a tributary of the Verde River, and Camp Creek northeast of Carefree both have perennial flow.

Streamgages are located at Del Rio Springs, along Willow and Watson Creeks, and on the Verde River in the Phoenix AMA. Mean flows at the three Granite Creek streamgages are between approximately 3,500 and 5,000 acre-feet a year. Flows on the Verde River in the Phoenix AMA are regulated by releases from Bartlett and Horseshoe Dams. The highest reported annual flow at the two Verde River gages was approximately 1.8 maf in 1993, while the median flow is approximately 298,000 acre-feet (Table 8.1-2).

Agua Fria – Lower Gila River

The Agua Fria – Lower Gila River Watershed begins near Prescott and extends south past Gila

Bend in the Lower Colorado River Planning Area. It includes drainage from the Agua Fria River, the Lower Hassayampa River and the Gila River. Within the AMA planning area, this watershed encompasses the southeastern portion of the Prescott AMA as well as the western half of the Phoenix AMA.

In the Prescott AMA, the Agua Fria – Lower Gila River Watershed includes the Upper Agua Fria Sub-basin. Upper Lynx Creek, Lynx Creek and the Agua Fria River drain the sub-basin. Most of the runoff from Lynx Creek is impounded by a dam and is reserved for recreational and industrial use. A short stretch of the Agua Fria River becomes perennial before leaving the AMA and a portion of it receives effluent discharged from the Prescott Valley Wastewater Treatment Facility (Figure 8.3-10). All other flows in the Upper Agua Fria Sub-basin are ephemeral.

All or portions of five Phoenix AMA sub-basins lie within the Agua Fria – Lower Gila River Watershed including Carefree, Lake Pleasant, Hassayampa, West Salt River Valley and Rainbow Valley. The Agua Fria River enters the AMA approximately 20 miles north of Peoria, in the Lake Pleasant Sub-basin. It is impounded by New Waddell Dam at the northern boundary of the sub-basin and only flows below the dam when water is released during major flood events. From there it flows south along the western edge of the Phoenix metropolitan area and joins the Gila River south of Avondale. Downstream of the confluence of the Salt River, the Gila River flows year round due to effluent discharge from the City of Phoenix 23rd and 91st Avenue wastewater treatment plants (WWTP) into the Salt River, and also from return flows from nearby agricultural areas. The Gila River has been designated as impaired by the Arizona Department of Environmental Quality (ADEQ) due to pesticide concentrations that exceed the use standard (Figure 8.1-10A and Table 8.1-8B). The water is diverted along the way for agricultural and industrial uses. The Gila River exits the Phoenix AMA at Gillespie Dam.

The Hassayampa River originates in the Bradshaw Mountains and flows into the Hassayampa Sub-basin to its confluence with the Gila River west of Buckeye. It is an ephemeral watercourse in the AMA with the exception of short perennial reaches where it enters the AMA and near the Gila River confluence. The Hassayampa River is impaired above the confluence due to high concentrations of selenium and boron (Table 8.1-8B and Figure 8.1-10A).

The only major spring in the watershed is Seven Springs north of Carefree with a discharge of about 75 gpm. Cave Creek and Seven Springs Wash located northeast of Carefree have perennial reaches (Figure 8.1-5).

Flow records from streamgages on watercourses in the watershed are shown in Tables 8.1-2 and 8.3-2. Annual median flow at the Agua Fria River near the Humboldt gage is about 3,400 acre-feet. Annual median flow on the Hassayampa River near Morristown is about 6,500 acre-feet a year. The highest flow measured in the watershed was at a gage on the Gila River (#9514100) with a flow of 6.1 maf in 1993, although the median flow at this gage is only about 12,000 acre-feet a year. (Table 8.1-2)

Salt River

Most of the Salt River Watershed is within the Salt River and Tonto Creek basins in the Central

Highlands Planning Area. Its western edge extends into the Phoenix AMA to the confluence of the Salt and Gila rivers. The Salt River originates in eastern Arizona and drains approximately 6,000 square miles of the Mogollon Rim area in the east-central part of the State. Before entering the Phoenix AMA in the Fountain Hills Sub-basin, surface water from the Salt River Watershed passes through a series of four reservoirs: Roosevelt Lake, Apache Lake, Canyon Lake and Saguaro Lake. These reservoirs and associated dams, operated by the SRP are used to supply water to the agricultural, municipal and industrial sectors in the Phoenix AMA. The Salt River channel enters the AMA north of the Goldfield Mountains; crosses toward the southwest through the East Salt River Valley and West Salt River Valley sub-basins and the cities of Mesa, Tempe, Scottsdale and Phoenix; and joins the Gila River near Laveen. Downstream from the Granite Reef Diversion Dam, the Salt River is ephemeral, only flowing in response to flooding or reservoir releases. The Salt River is perennial further downstream due to effluent discharges from the 23rd Avenue and 91st Avenue WWTPs.

There are no major springs in the AMA portion of the watershed. Flow records from streamgages in the watershed are found in Table 8.1-2. Annual median flow on the Salt River below Stewart Mountain Dam is about 585,700 acre feet with a maximum flow of over 3.2 maf in 1993. Further downstream near its confluence with the Gila River and below the Granite Reef Diversion Dam, annual median flow on the Salt River at 51st Avenue is about 4,300 acre-feet a year.

Middle Gila River

The Middle Gila River Watershed extends west from Coolidge Dam on the Gila River, located in the Southeastern Arizona Planning Area, to the confluence of the Gila and Salt Rivers. The San Pedro and San Francisco rivers are major tributaries to the Gila River outside of the AMA Planning Area. Portions of the Phoenix AMA, Pinal AMA and Tucson AMA are located in this watershed. The Gila River enters the Pinal AMA in its northeastern corner and traverses from east to west. In predevelopment times, the Gila flowed year round through this area. Pre-development flows on the portion of the Gila River that passes through the Pinal AMA are estimated to have been about 500,000 acre-feet per year. The first records of San Carlos Irrigation Project (SCIP) diversions begin in 1930, although diversions to non-Indian farmers began much earlier. Annual diversions from the Gila River by SCIP at Ashurst-Hayden Diversion Dam northeast of Florence in the Pinal AMA have averaged 245,000 acre-feet per year from 1930 to 1995.

There are no major springs in this portion of the Middle Gila River watershed. Short reaches of Queen Creek and Arnett Creek near Superior are perennial. Queen Creek has been designated as impaired from its headwaters about nine miles downstream due to elevated copper concentrations from mining discharge (Table 8.1-8B and Figure 8.1-10A). Flow records from streamgages in the watershed are found in Tables 8.1-2 and 8.2-2. Annual median flow measured at the streamgage, “Queen Creek below Whitlow Dam near Superior”, is about 1,600 acre-feet. Gages on the Gila River are either discontinued or have only recent data. The Gila River near Laveen gage has the longest period of record, 55 years, but was discontinued in 1994. The annual median flow at that gage was 9,420 acre-feet with a maximum flow of almost 1.2 maf in 1993.

Santa Cruz River

A large portion of the AMA Planning Area falls within the Santa Cruz River Watershed, including the Santa Cruz AMA and most of the Tucson and Pinal AMAs. The Santa Cruz River is the main

surface water drainage in the Santa Cruz and Tucson AMAs. The river originates in the San Rafael Valley east of the planning area and flows southward to Mexico before turning north and re-entering the U.S. east of Nogales. Within the planning area it extends from the international border northwestward to its confluence with the Gila River (where it is known as the Santa Cruz Wash) in the northern portion of the Pinal AMA. Major tributaries to the river in the Santa Cruz AMA are Nogales Wash, Sopori Wash and Sonoita Creek. Tributaries to the Santa Cruz River in the Tucson AMA include Rillito Creek, Cañada del Oro Wash and Brawley Wash. Three smaller streams (Vekol Wash, Santa Rosa Wash and Aguirre Wash) drain the southwestern portion of the Pinal AMA. These washes join Santa Cruz Wash upstream from its confluence with the Gila River.

Prior to development, the Santa Cruz River was mostly perennial in its southernmost reach from its headwaters in the San Rafael Valley to near Tubac, often as a series of Cienegas (marshes). North of Tubac, a few short perennial reaches existed including reaches near the mission of San Xavier del Bac south of Tucson and at “A” Mountain near downtown Tucson. From the Nine-Mile water hole north of the confluence of the Santa Cruz River and the Rillito River in Tucson, to its confluence with the Gila River, the Santa Cruz River was dry except during floods. (Tellman, et al., 1997)

Currently, within the Tucson AMA and the Santa Cruz AMA, two segments of the Santa Cruz River flow year round due to wastewater discharges. In 2006, approximately 54,000 acre-feet was discharged at the Ina and Roger Road WWTPs by Pima County. In 2004, approximately 16,200 acre-feet of sewage was treated at the Nogales International WWTP, which treats sewage from both Nogales, Sonora and Nogales, Arizona prior to discharge to the river. Approximately 11,500 acre-feet of the influent was from Mexico. In the Pinal AMA, a portion of the Santa Cruz River receives wastewater discharge from the Casa Grande WWTP. Other perennial flows include portions of Sabino, Romero, Cienega and Rincon Creeks in the east central part of the Tucson AMA and Sonoita Creek in the Santa Cruz AMA. Nogales Wash, a tributary of the Santa Cruz River, originates about five miles south of the international border in Sonora and enters Arizona as a covered floodway. It joins the Santa Cruz River about 8 miles north of the border. Nogales Wash is the major drainage system for both Nogales, Arizona and Nogales, Sonora. (Varady, et al., 1995) Springs create perennial flow in Nogales Wash near its headwaters in Mexico and below the springs, storm flows and uncontrolled sewage discharges also contribute to its flow (IBWC, 1998). In the Santa Cruz AMA the Santa Cruz River and Nogales Wash have designated impaired reaches due to elevated levels of *E. coli* and other constituents (Figure 8.4-9 and Table 8.4-7).

There are ten major springs in the watershed located near Arivaca, in mountains east of Tucson, and west of Amado in the Santa Cruz AMA. The spring with the largest discharge is Sopori, located west of Amado, with a discharge rate of 377 gpm measured in 1952 (see Tables 8.4-5 and 8.5-5).

Flow records from streamgages in the watershed are found in Tables 8.4-2 and 8.5-2. The annual median flow at the Santa Cruz River near Nogales is 14,013 acre feet with a maximum flow of over 88,000 acre-feet in 1983. Downstream, median flow at the gage on the Santa Cruz River at Cortaro is 38,655 acre-feet with a maximum flow in 1993 of over 182,000 acre-feet.

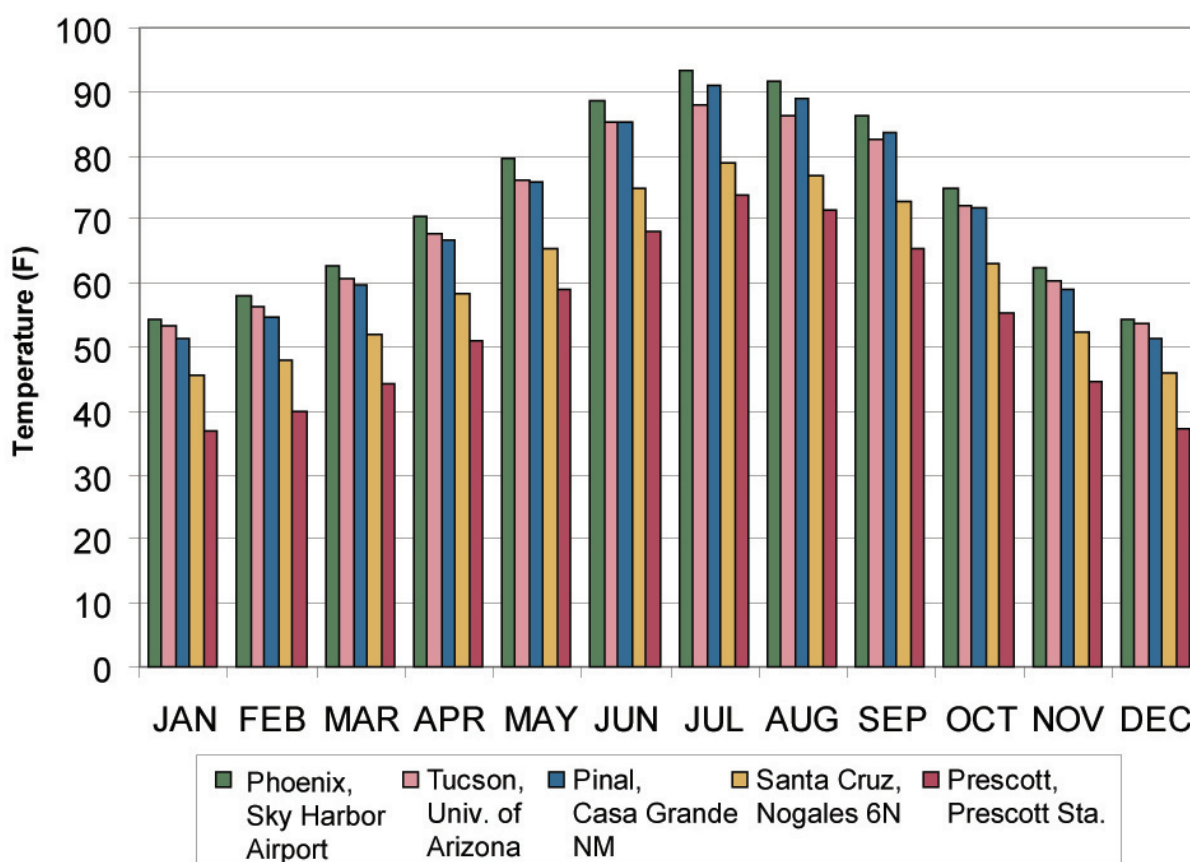
Rio Asuncion

A small part of the Rio Asuncion Watershed is located at the base of the Tucson AMA along the international border. This watershed drains a large area of northwest Sonora, Mexico and discharges into the Sea of Cortez. Sycamore Creek, a perennial stream located in this watershed, flows south-southwest into Mexico. Due to its rich biological diversity, a portion of Sycamore Canyon has been designated as the Gooding Research Natural Area.

8.0.3 Climate

Climate in the AMA Planning Area varies widely due to its geographic extent, with significant temperature and rainfall differences between some AMAs. Average annual temperatures range from 72.9°F in the Phoenix AMA to 53.3°F in the Prescott AMA compared to the statewide average of 59.5°F. Phoenix and Tucson are the warmest AMAs except during the summer monsoon season when Tucson receives a significant amount of its annual rainfall and associated cooler temperatures (Figure 8.0-5). Average annual precipitation (1971-2000) ranges from 8.3 inches at Phoenix Sky Harbor Airport to 18.7 inches at Nogales and Prescott.

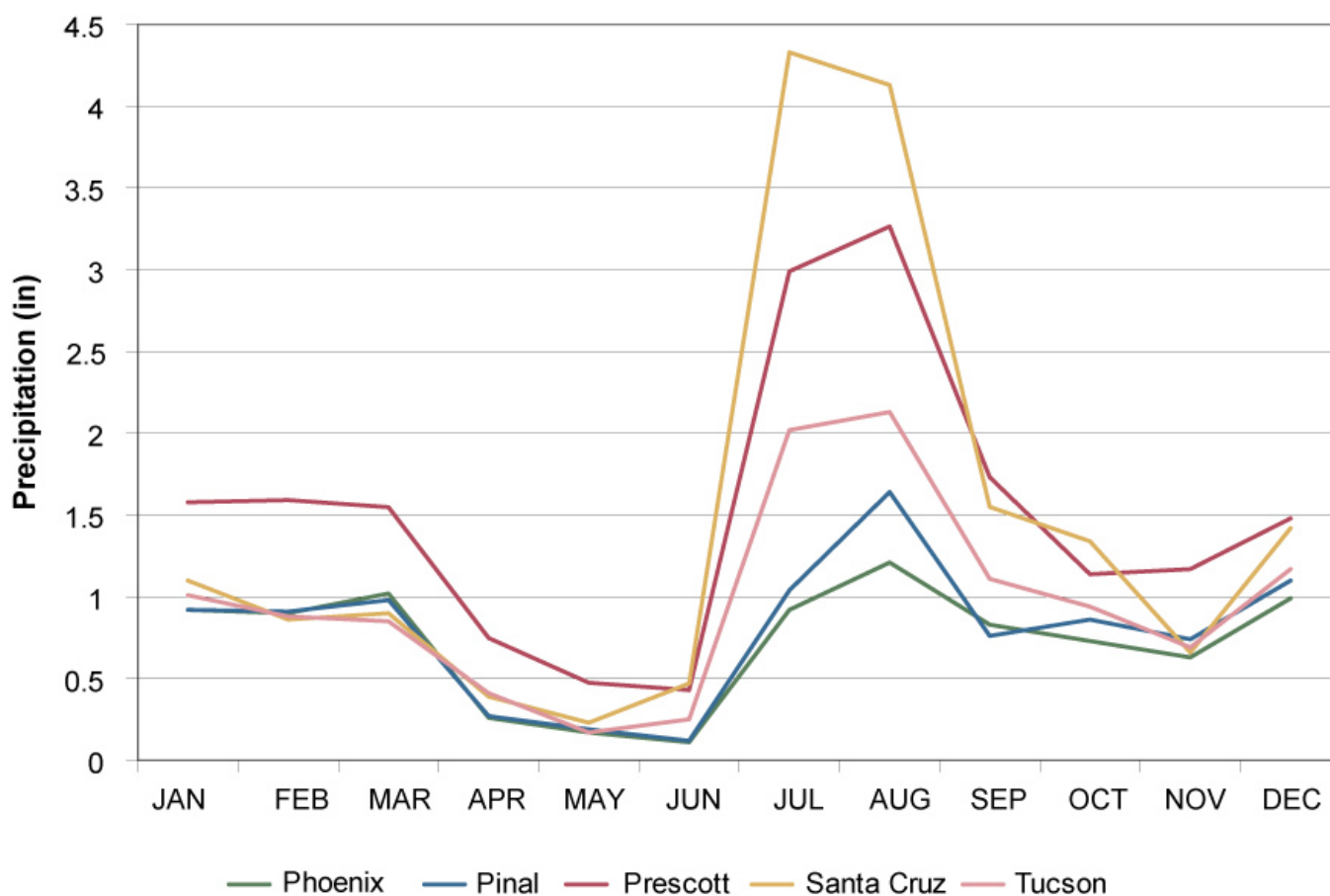
Figure 8.0-5 Average monthly temperature from 1952-2007 in the AMA Planning Area



Source: WRCC, 2008

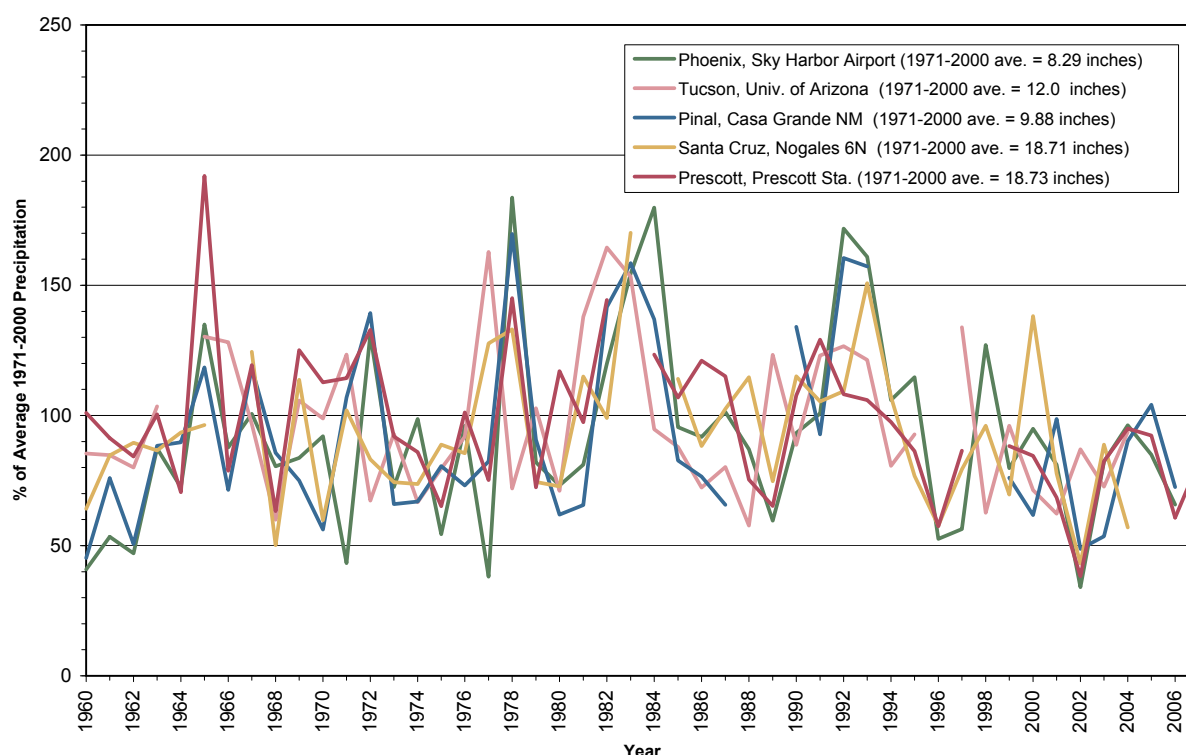
The AMA Planning Area exhibits a bi-modal precipitation seasonality that is characteristic of Arizona (Figure 8.0-6). During the winter and spring, frontal storm systems move west-to-east, guided by the jet stream. Summer monsoon thunderstorms also deliver significant amounts of precipitation, particularly in the Santa Cruz AMA. While precipitation amounts vary widely across the planning area, there are also strong year-to-year variations, due primarily to the influence of the El Nino-Southern Oscillation, as well as long-term wet and dry periods that are linked to multi-decadal ocean variations. Many of the wettest and driest periods since 1960 were synchronous throughout the AMAs with notable wet periods in the late 1970s, early 1980s and early 1990s. Notable dry periods were the early 1960s, the early 1970s and the period from 1996 through 2006 (Figure 8.0-7). The greatest year-to-year precipitation variations during this period occurred in the Phoenix AMA and the least variation in the Prescott AMA, with the exception of 1965 when Prescott received almost double its annual rainfall.

Figure 8.0-6 Average monthly precipitation from 1948-1952 to 2006-2007



Note: Data are from Phoenix, Sky Harbor Airport; Casa Grande NM; Prescott Sta.; Nogales 6N; and Univ. of Arizona WRCC Stations.
Source: WRCC, 2008

Figure 8.0-7 Annual percent of average precipitation measured between 1960-2007



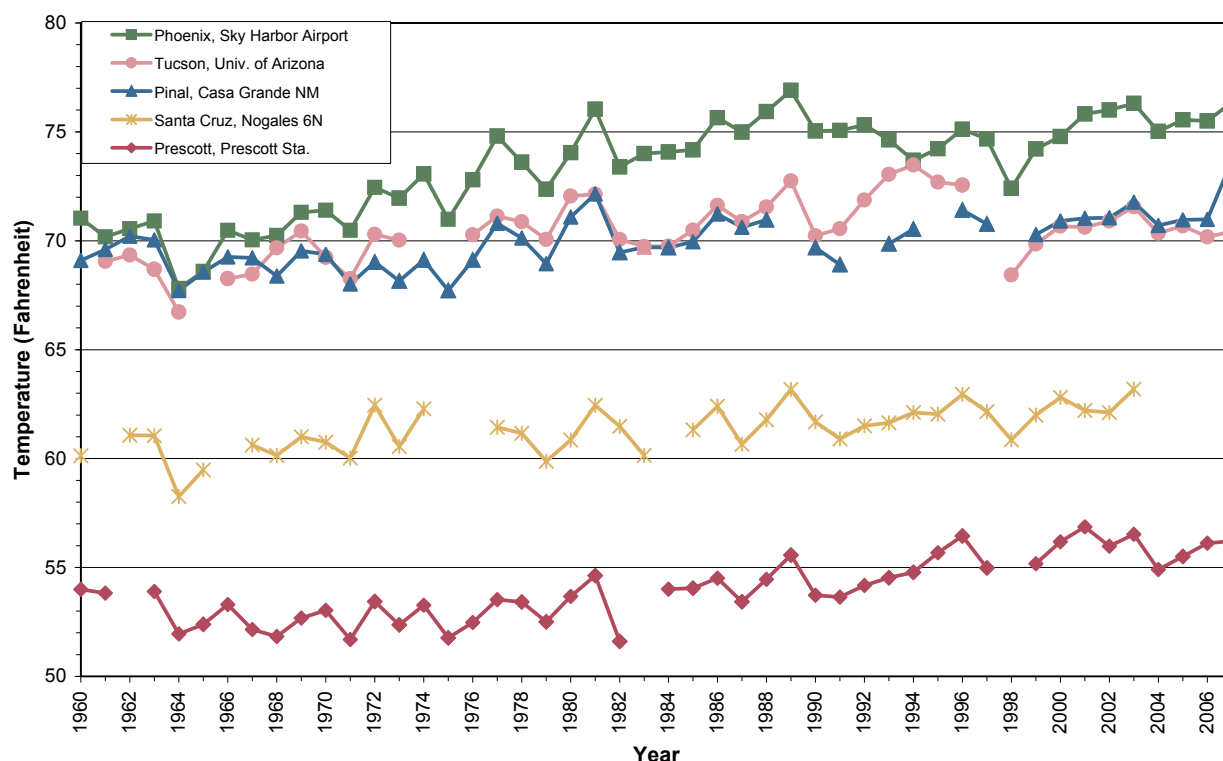
Years with more than five days of missing data in any month were omitted. Each time series was constructed from one recording station. Figure author: Zack Guido, CLIMAS

The planning area encompasses parts of five of Arizona's seven climate divisions. A climate division is a region within a state that is generally climatically homogenous. Long-term climate data for Arizona's climate divisions have been reconstructed from tree ring and instrumental data. These data show that since 1000 A.D., Climate Division 7 experienced more years than the other planning area climate divisions in which precipitation was less than that measured in 2002, one of the driest years in the instrumental record (CLIMAS, 2008). Climate Division 7 encompasses most of the Tucson AMA and all of the Santa Cruz AMA.

Average annual temperatures in the AMA Planning Area have been increasing since 1960, a phenomenon observed throughout the state. Figure 8.0-8 shows that all of the major urban locations in the AMAs have seen temperature increases, reflecting both a regional temperature trend and the influence of urban expansion and development. The effect of urban areas on temperature, precipitation and other climate phenomena is an important consideration in the planning area. Phoenix, for example, has experienced the greatest increase in temperatures during the time period shown. Figure 8.0-9 illustrates an increase in daily minimum temperatures during the summer months in Phoenix and Tucson, and is contrasted with the modest increases measured at Casa Grande National Monument, a relatively non-urbanized area between the two cities.

Research on urbanization and warming in the Phoenix metropolitan area shows that, from 1948-2000, urbanization has increased the nighttime minimum temperature in central Phoenix

Figure 8.0-8 Average annual temperature measured between 1960 and 2007

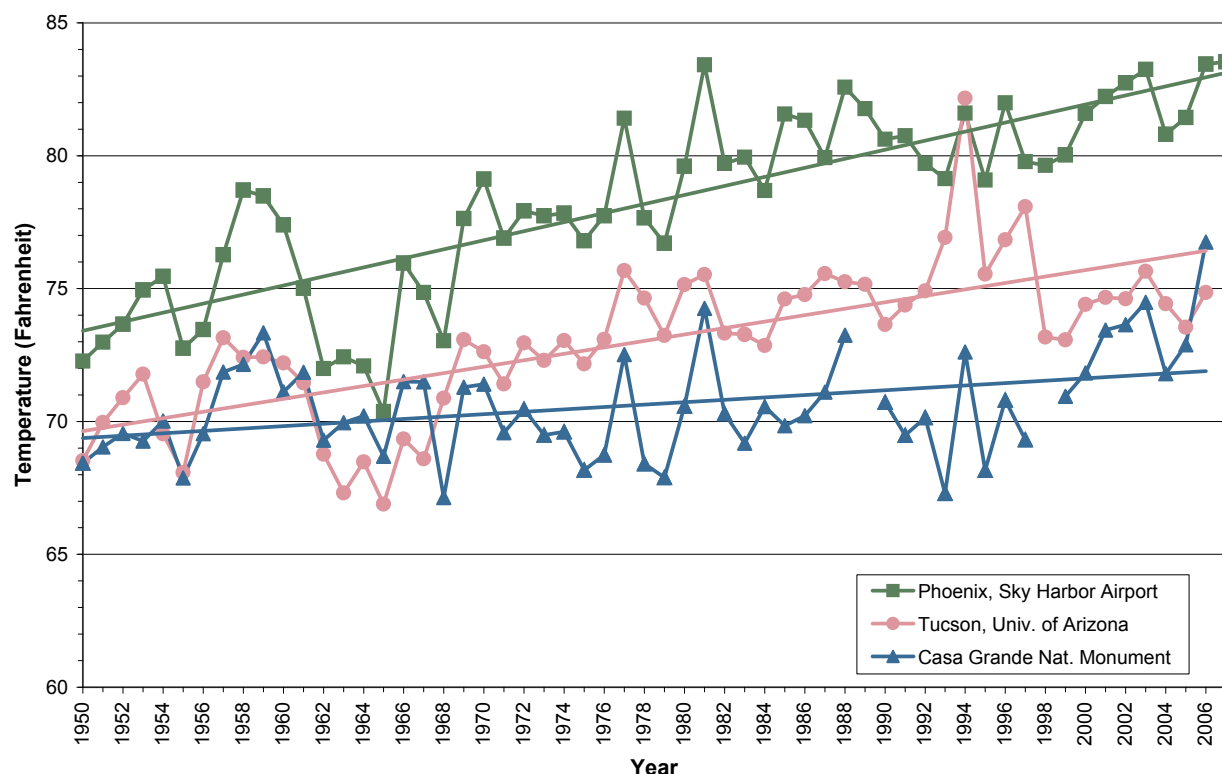


Each time series was constructed from one recording station. Figure author: Zack Guido, CLIMAS

(Sky Harbor Airport) by approximately 9° F and the average daily temperature by approximately 5.5° F (Baker et al., 2002). The number of days with temperatures between 59-100°F at Sky Harbor Airport has increased by about 30 days since 1948, most notably during the spring and fall. During the period 1990-2004, the Phoenix urban heat island expanded substantially, commensurate with increasing population and urban development. Recent research shows that temperatures in areas characterized by urban infill development, and areas in the core of the city were approximately 2° F and approximately 4° F warmer, respectively, than temperatures outside of urban areas (Brazel et al., 2007). Similarly, in central Phoenix the hours per day that exceed 100° F during the months of May through September have doubled since 1948 (Baker et al., 2002).

Tucson's urban heat island effect increased by approximately 5.5° F during the 20th century, with most of the warming since the late 1960s (Comrie, 2000). In the Tucson area, urban temperatures increased at almost 3 times the rate of rural temperatures. Temperature changes are not, however, uniform. Within the urban zone, variations in temperatures are caused by differences in housing density, the amount of green space, topography, and localized cold air flows downslope from mountains.

The impacts of urban warming are varied and include increases in energy consumption, predominantly from longer usage of air conditioning, and stress to animals and humans. Since 1948, the total number of cooling degree days (CDD) in Phoenix has increased by 569 while the

Figure 8.0-9 Average June, July and August temperature measured between 1960 and 2007

Years with more than five days of missing data in any month were omitted. Each time series was constructed from one recording station. Figure author: Zack Guido, CLIMAS

heating degree days (HDD) has declined by 331 (Baker et al., 2002). The CDD and HDD are indices that reflect the demand for energy needed to cool or heat a structure, respectively. Research conducted in 2003 in Phoenix found that distinct neighborhoods experience up to 7° F difference in temperature.

Two recent studies suggest that urbanization and large irrigated areas in the Phoenix metro area increase precipitation to the northeast of the city (Diem and Brown, 2003; Sheperd, 2006). Average precipitation in the northeastern suburbs and exurbs of metropolitan Phoenix has increased by 12-14%, in contrast to the first half of the 20th century (Sheperd, 2006). The study suggests that urban heating, from built surfaces and buildings, affects upward motion in the atmosphere and can increase storminess beyond the urban area. Irrigation increases local water vapor in the atmosphere, and probably contributes to the increased precipitation (Diem and Brown, 2003).

8.0.4 Environmental Conditions

Vegetation

Information on ecoregions and biotic (vegetative) communities in the AMA Planning Area is shown on Figure 8.0-10. The planning area contains five of the six ecoregions found in Arizona; most of the planning area is within the Sonoran Desert ecoregion. The Tucson and Santa Cruz AMAs,

in the southern portion of the planning area, contain Chihuahuan Desert with areas known as “sky islands” of Sierra Madre Occidental pine-oak forest. The northeastern portion of the Phoenix AMA and most of the Prescott AMA are in the Arizona Mountains forests region, and the northern portion of the Prescott AMA includes a portion of the Colorado Plateau shrublands region.

Biotic communities range from Lower Colorado River Valley Sonoran desertscrub to Rocky Mountain (Petran) and Madrean montane conifer forest. Most of the planning area is covered by Lower Colorado River Valley and Arizona Uplands Sonoran desertscrub biotic communities.

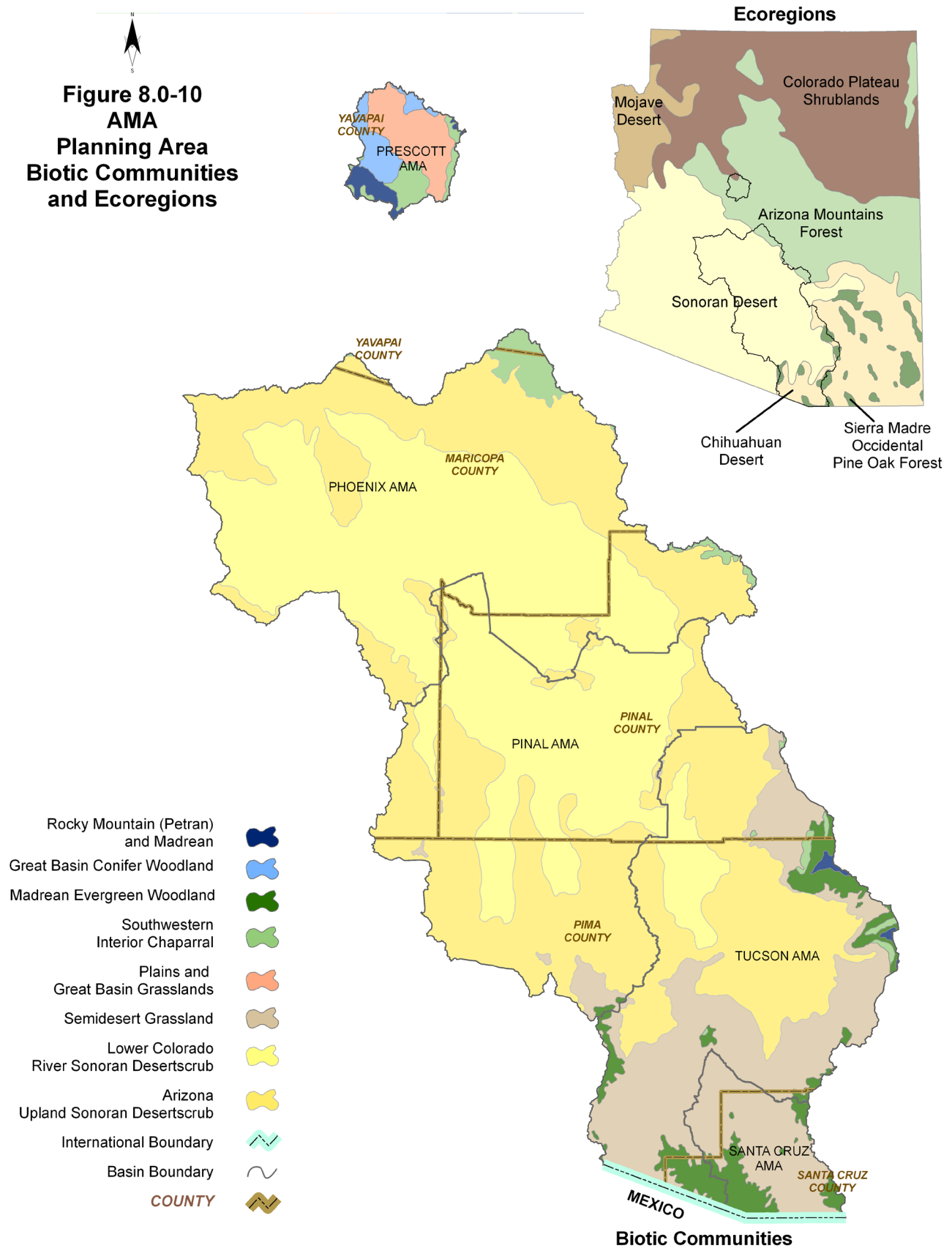
Rocky Mountain and Madrean montane conifer forests occur at the highest elevations of the Tucson AMA in the Santa Catalina and Rincon Mountains and in the Prescott AMA in the Bradshaw Mountains. These forests commonly occur between about 7,200 to 8,700 feet. Above 8,000 feet, in areas that receive from 25 to 30 inches of annual rainfall, the forest contains a mix of conifers that may include Douglas and White fir, Limber Pine, Blue Spruce, and White Pine, with Ponderosa Pine on warmer slopes. Aspen and Gambel Oak are prominent in these forests following disturbances. Below 8,000 feet, in areas that receive about 18 to 26 inches of annual precipitation, the mix of species gives way to almost pure stands of Ponderosa Pine. About half of the precipitation occurs during the growing season, which permits forests to exist on less than 25 inches of annual rainfall, making them some of the driest forests in North America (Brown, 1982). Bark beetle infestations have killed large areas of Ponderosa Pine in the Prescott AMA within and in the vicinity of the City of Prescott.

Higher elevations in the Prescott AMA contain areas of Great Plains grassland and Great Basin conifer woodland not found in the other four AMAs. Great Basin Conifer (piñon-juniper) woodlands are found at elevations between about 5,000 and 7,500 feet that receive about 10 to 20 inches of annual precipitation. One of the most extensive vegetation types in the southwest, it is characterized by juniper and piñon pine trees. Great Plain grasslands, primarily composed of mixed or short-grass communities, are located in the center of the AMA at elevations above about 4,000 feet that receive between 11 and 18 inches of annual precipitation. (Brown, 1982).

Madrean evergreen woodlands are relatively widespread in the Tucson and Santa Cruz AMAs. This community occurs in the Santa Catalina, Baboquivari and Santa Rita Mountains and in the mountain ranges along the U.S.-Mexico border where the mean annual precipitation exceeds 16 inches. The woodland consists of evergreen oaks, Alligator Bark and One-seed Junipers, and Mexican Pinyon Pine, and transitions to semidesert grassland at lower elevations. Cacti of the semidesert grassland may extend into the woodland. (Brown, 1982)

Semi-desert grasslands occur predominantly in the Santa Cruz and Tucson AMAs with smaller areas in the Pinal AMA. These grasslands occur at elevations between 3,500 and 5,000 feet that receive annual precipitation of 10 to 17 inches. Grasses were originally perennial bunch grasses with intervening areas of bare ground. Where heavily grazed, grasses have shifted to annual species where summer rainfall is low, or to low growing sod grasses where rainfall is moderate to heavy. Shrubs, cacti and herbaceous plants are commonly found in the semi-desert grassland community. (Brown, 1982)

Figure 8.0-10
AMA
Planning Area
Biotic Communities
and Ecoregions



Biotic Communities Source: Browne and Lowe, 1980
Ecoregions Source: Olson et al, 2001

Interior chaparral occupies mid-elevation foothill and mountain slopes in the Santa Rita Mountains in the Tucson AMA, the Superstition Mountains in the Phoenix AMA and the Bradshaw Mountains in the Phoenix and Prescott AMAs. Interior chaparral occurs in areas between about 3,500 and 6,000 feet that receive 15 to 25 inches of annual precipitation (Brown, 1982). Typical shrubby species are Mountain Mahogany, Shrub Live Oak, and Manzanita. Chaparral plants are well adapted to drought conditions.

Two subdivisions of the Sonoran desertscrub region, the Lower Colorado River Valley subdivision and the Arizona Upland subdivision, dominate all but the Prescott AMA. The Lower Colorado River Valley subdivision is the hottest and driest of the Sonoran desertscrub subdivisions. There is intense competition for water, with plants widely spaced and more concentrated along drainage channels. Characteristic plants include Creosote Bush, Bursage, Saltbush, and mixed, more diverse vegetation along washes and other areas with more water. These areas may include Blue Palo Verde, Ironwood and Jojoba. Also commonly found in the subdivision are several types of cholla and other cacti. (Brown, 1982)

The Arizona Upland subdivision borders the Lower Colorado River Valley subdivision and occurs primarily on slopes and sloping plains at elevations of 980 to over 3,000 feet where it merges with interior chaparral or semi-desert grassland. This subdivision receives more precipitation than the other Sonoran desertscrub subdivisions with average annual precipitation between 8 to 16 inches. Vegetation is scrubland or low woodland in appearance with Blue and Foothill Palo Verde, Ironwood, Mesquite and Cat-Claw Acacia as common tree species. Cacti are extremely important in this subdivision including Saguaro, Organ Pipe, cholla and barrel cacti. (Brown, 1982)

The occurrence and composition of riparian vegetation has changed along many of the watercourses in the AMA Planning Area, including the Santa Cruz River in the Santa Cruz and Tucson AMAs, the Gila River in the Pinal and Phoenix AMAs, and the Salt and Verde Rivers in the Phoenix AMA.

Riparian vegetation has increased in most reaches of the Santa Cruz River upstream from Tucson that have perennial flow from either base flow or sewage effluent, while there has been complete destruction of the riparian ecosystem at Tucson. Cottonwood and willow have increased in density upstream of developments, but in areas where development is up to the river, cottonwood trees have been eliminated. In the late 1990s and early 2000s, die-off of riparian trees occurred at Nogales and near Rio Rico respectively, and may be related to excessive groundwater pumping. North of Tucson, effluent discharge supports a relatively newly established riparian ecosystem. North of Marana, the Santa Cruz River is ephemeral and there is little historic evidence of riparian vegetation with the exception of tamarisk. Tamarisk density may be increasing at some locations (Webb, et al., 2007)

Riparian vegetation on the Gila River has significantly declined between Florence in the Pinal AMA and its confluence with the Salt River in the Phoenix AMA due to surface water diversion and groundwater pumpage. This section historically supported reaches of lush, woody riparian vegetation, but now mostly tamarisk and mesquite are found. However, cottonwood has returned along the Gila River near its confluence with the Salt River due to increasing groundwater levels

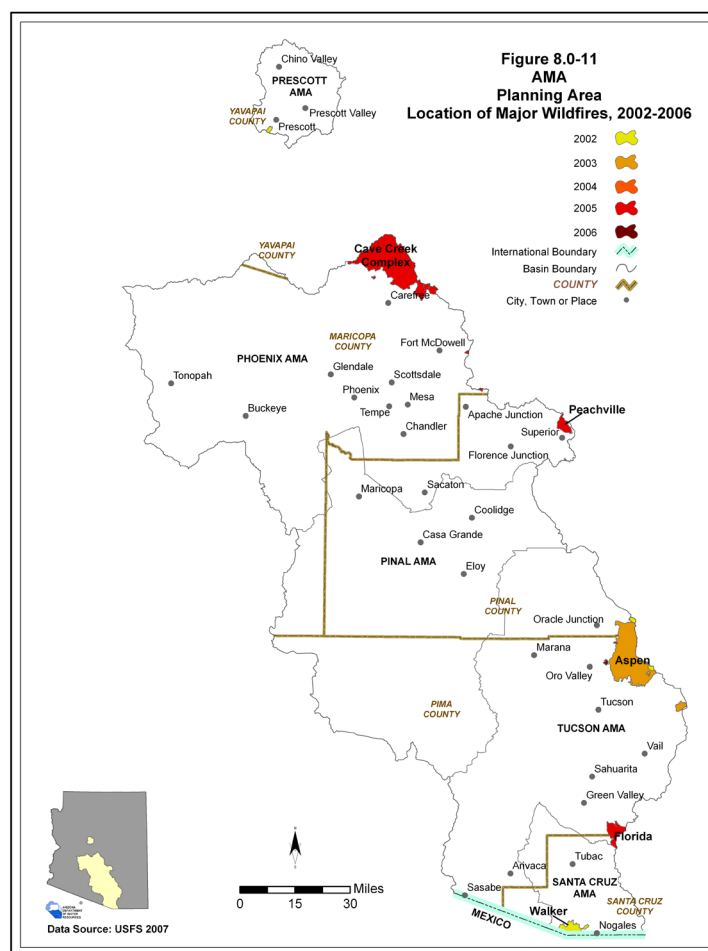
and changes in the flow regime of the Salt River. Historic and current groundwater levels are high at the confluence of the Gila and Salt rivers, supporting a cottonwood-willow forest surrounded by “a sea of tamarisk” (Webb, et al., 2007). Effluent discharge from the City of Phoenix and agricultural return flow have created perennial flow and increased riparian vegetation below the confluence, where vegetation is primarily tamarisk and mesquite with small stands of cottonwood-willow (AZGF, 1993).

The reservoir system on the Salt River has stabilized the channel in the Phoenix AMA below the dams (except during large flood events) and allowed establishment of native and nonnative (primarily tamarisk) riparian vegetation. Below its confluence with the Verde River and Granite Reef Dam, most of the surface flow of the Salt River is diverted, and the riparian vegetation declines and disappears downstream to the effluent-dependent section near the confluence of the Salt and Gila rivers. Downstream of Bartlett Dam, native and nonnative riparian vegetation has increased along the Verde River due to relatively steady release of water. (Webb, et al., 2007) Vegetation includes cottonwood-willow, tamarisk and mesquite (AZGF, 1993).

Concerns about receding riparian areas at some locations have resulted in restoration projects in the Phoenix and Tucson metropolitan areas, including the Rio Salado project in downtown Phoenix in the Phoenix AMA; and the San Xavier Riparian Restoration project on the Tohono O’odham Reservation, south of Tucson in the Tucson AMA.

Many of the natural biotic communities in the planning area are threatened by invasive species that interfere with ecosystem function through altering natural fire, nutrient flow and flooding regimes. The most problematic invasive species include: buffelgrass, fountaingrass, Natalgrass, onionweed, Sahara mustard and tamarisk. Numerous agencies and interest groups throughout the planning area have come together to control the spread of these species where feasible, and to educate the public about the threat of these species to ecosystem function. (ASDM, 2008)

Although not necessarily caused or exacerbated by invasive species, several major wildfires occurred in the AMA Planning Area during the recent drought years between 2002-2006 (see Figure 8.0-11). The 2003 Aspen fire in the Tucson AMA burned 85,000 acres, including much of the Town of Summerhaven. The 2005 Cave Creek Complex fire, of which a portion is located in the Phoenix AMA, burned 243,950 acres and is the second largest fire in Arizona to date. Both of these fires occurred in areas with



perennial streams and have had documented impacts on peak-flow events. Rainfall two months after the Aspen fire caused runoff to increase three-fold over pre-burn runoff in the Sabino Creek watershed. (Schaffner and Reed, 2007) Increased peak flows can degrade stream channels and make them unstable, increase sediment production, and cause flood damage (Neary, et al., 2003).

Arizona Water Protection Fund Programs

The objective of the Arizona Water Protection Fund (AWPF) program is to provide grants for the protection and restoration of Arizona's rivers and streams and associated riparian habitats. Thirty-two restoration projects in the AMA Planning Area had been funded by the AWPF through 2005. Six projects were funded in the Phoenix AMA for wetland construction, exotic species control, revegetation and general research. One habitat protection project was funded in the Pinal AMA. Six grants in the Prescott AMA funded feasibility studies, general research and stream restoration. In the Tucson AMA fifteen projects, including general research, habitat restoration and exotic species control, were funded. Finally, four research and revegetation projects were funded in the Santa Cruz AMA. A list of projects and project types funded in the AMA Planning Area through 2005 is found in Appendix A of this volume. A description of the program, a complete listing of all projects funded, and a reference map are found in Appendix C of Volume 1.

Instream Flow Claims

An instream flow water right is a non-diversionary appropriation of surface water for recreation and wildlife use. Fourteen applications for instream flow claims have been filed in the AMA Planning Area. The applications are listed in Table 8.0-1 and are shown on Figure 8.0-12. Claims have been filed in three of the five AMAs, including Phoenix, Tucson and Santa Cruz; and six certificates have been issued, all in the Phoenix AMA. Certificates have been issued for claims on Arnett Creek, Camp Creek, Cave Creek, Hassayampa River, Seven Springs Wash and Sycamore Creek. Claims have been filed for stretches of Queen Creek Wash, Rincon Creek, Sabino Creek and Sonoita Creek.

Table 8.0-1 Instream flow claims in the AMA Planning Area

Map Key	Stream	Applicant	Application No.	Permit	Certificate No.	Filing Date
1	Arnett Creek	Tonto National Forest	33-96235.0	96235	96235	10/20/1992
2	Camp Creek	Tonto National Forest	33-96693.0	96693	96693	7/5/2001
3	Cave Creek	Desert Foothills Land Trust	33-96255.0	Pending	Pending	3/25/1993
3	Cave Creek	Tonto National Forest	33-96302.0	96302	96302	9/27/1993
4	Hassayampa River	Nature Conservancy	33-92304.0	92304	92304	1/20/1987
5	Queen Creek	Boyce Thompson Arboretum	33-92298.0	Pending	Pending	1/20/1987
6	Rincon Creek	Saguaro National Park	33-96733.0	Pending	Pending	12/10/2002
7	Sabino Creek	Joseph and Lynette Marco	33-87168.1	Pending	Pending	4/17/2001
7	Sabino Creek	Sierra Club, et al	33-93232.0	Pending	Pending	7/28/1987
7	Sabino Creek	Hidden Valley HOA	33-96551.0	Pending	Pending	5/5/1997
8	Seven Springs Wash	Tonto National Forest	33-96303.0	96303	96303	9/27/1993
9	Sonoita Creek	AZ State Parks Board	33-96709.0	Pending	Pending	2/14/2002
9	Sonoita Creek	AZ State Land Department	33-93287.0	Pending	Pending	8/7/1987
10	Sycamore Creek	Tonto National Forest	33-96509.0	96509	96509	5/15/1996

**Figure 8.0-12
AMA
Planning Area
Instream Flow Applications**

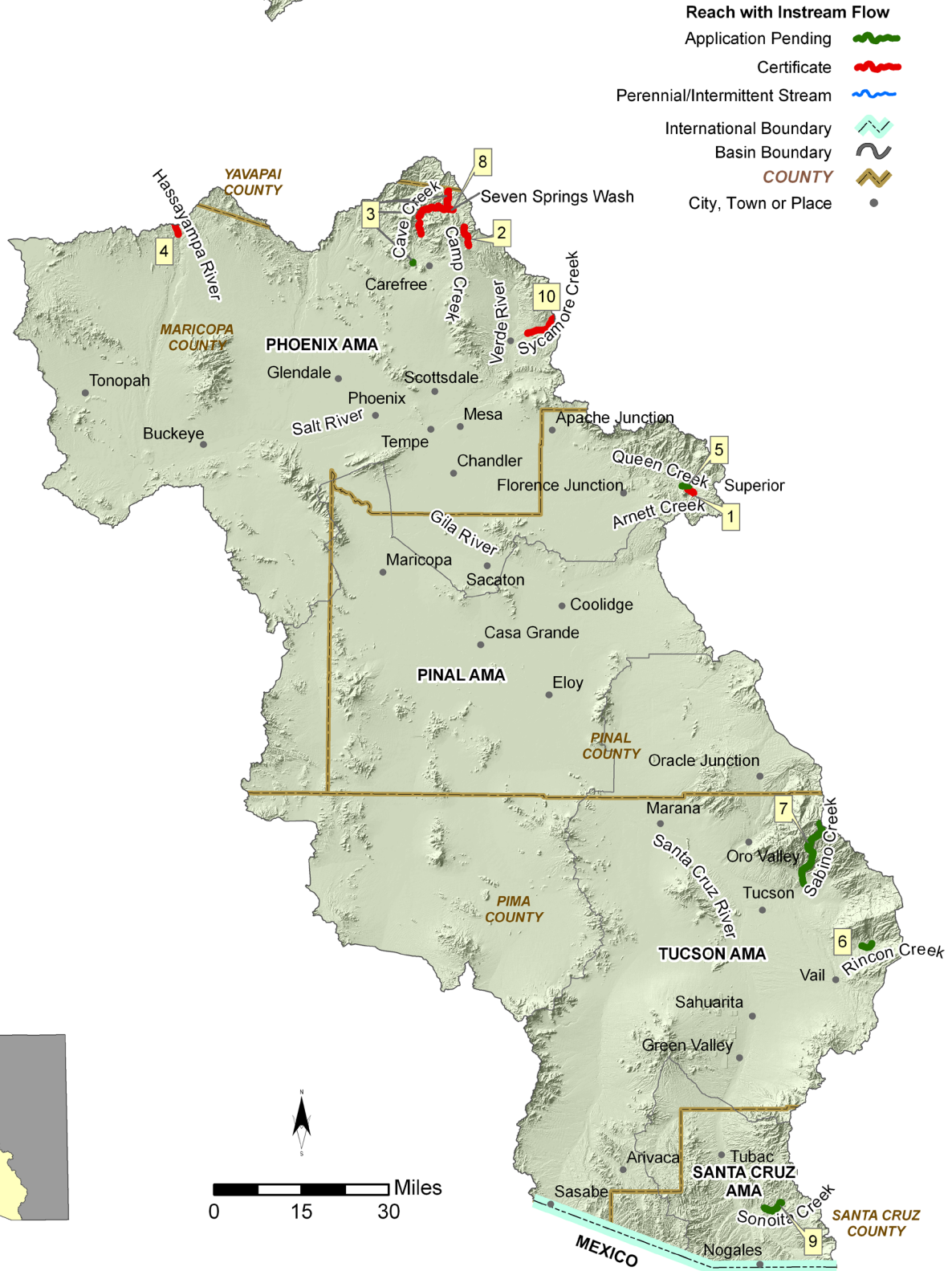


Table 8.0-2 Listed threatened and endangered species in the AMA Planning Area

Common Name	AMA	Threatened	Endangered	Elevation/Habitat
Arizona Agave	PHX		X	3,000 ft./steep, rocky granite slopes, or level hilltops, near chaparral; New River and Sierra Ancha Mountains.
Arizona Cliff Rose	PRE		X	<4,000 ft./White soils of tertiary limestone lakebed deposits.
Bald Eagle*	PHX, PRE	X		Varies/Large trees or cliffs near water.
Chiricahua Leopard Frog	TUC, SAN	X		3,300-8,900ft./Streams, rivers, backwaters, ponds stock tanks.
Desert Pupfish	TUC, PHX		X	<5,000 ft./Shallow springs, small streams and marshes. Tolerates saline and warm water.
Gila Topminnow	TUC, PHX		X	<4,500 ft./Small streams, springs and cienegas vegetated shallows.
Huachuca Water-umbel	TUC		X	2,000 - 6,000 ft /Cienegas or marshy wetlands within Sonoran desertscrub, grassland or oak woodland, and conifer forest.
Jaguar	TUC		X	Approx > 5,000 ft/Lowland wet habitats and oak-pine woodland.
Kearny's Blue Star	TUC		X	3,685 - 4,500 ft/Canyon bottoms and sides in oak woodlands.
Lesser Long-Nosed Bat	SAN, TUC, PHX		X	1,190 - 7,320 ft./Desert grassland and shrubland up to oak transition.
Masked Bobwhite Quail	TUC		X	3,090 - 3,720 ft. /Broad valley desert grassland.
Mexican Spotted Owl	TUC, SAN	X		4,100-9,000 ft./Canyons, dense forests with multi-layered foliage structure.
Nichol's Turk's Head Cactus	PIN, TUC		X	2,400-4,100 ft./Sonoran desertscrub.
Ocelot	TUC, SAN		X	<4,000 ft/Subtropical thorn forest, thorn scrub and dense brushy thickets, often in riparian bottomland.
Pima Pineapple Cactus	TUC, SAN		X	2,300 - 5,000 ft /Ridges in semidesert grassland and alluvial fans in Sonoran desertscrub.
Razorback Sucker	PHX		X	<6,000 ft./Riverine and lacustrine areas, not in fast moving water.
Sonora Chub	TUC	X		<1,000 - 4,000 ft./Large, deep and most permanent pools in Sycamore Creek.
Southwestern Willow Flycatcher	PHX, SAN		X	<8,500 ft./Cottonwood-willow and tamarisk along rivers and streams.
Yuma Clapper Rail	PHX, PIN		X	<4,500 ft./Fresh water and brackish marshes.

*As of 05/01/08 the Bald Eagle is listed as threatened only in the Southwest Region (Region 2).

Sources: AZGF 2008, USFWS 2007

Threatened and Endangered Species

A number of listed threatened and endangered species may be present in the AMA Planning Area. Those listed by the U.S. Fish and Wildlife Service (USFWS) as of January 2008 are shown in Table 8.0-2.² Presence of a listed species may be a critical consideration in water resource management and supply development in a particular area. The USFWS should be contacted for details regarding the Endangered Species Act (ESA), designated critical habitat, and current listings.

As shown on Table 8.0-2 the number and type of endangered or threatened species vary by AMA, with only one in the Prescott AMA and twelve in the Tucson AMA. Habitat encroachment by development and growth in the Tucson AMA, primarily in Pima County, required Pima County to develop a Multi-Species Conservation Plan (MSCP). No such plans affect the other AMAs.

The Pima County MSCP was created to comply with the “take” provisions of the ESA.³ Incidental take of a listed species, as the result of carrying out an otherwise lawful activity, is not allowed without a permit from the USFWS.⁴ The Pima County MSCP includes 55 “Priority Vulnerable Species” and will mitigate the effects of development through preservation of 58% of the land in the permit area as open space. The most recent version of the Pima County MSCP was released in August 2006. (Pima County, 2006a) An incidental take permit has not yet been issued by the USFWS.

The Pima County MSCP is part of a larger planning effort known as the Sonoran Desert Conservation Plan (SDCP), which covers 5.9 million acres in Pima County and is focused on six elements: habitat, corridors, cultural resources, mountain parks, ranch conservation and riparian protection. The SDCP planning process began in 1998 as a way to create a science-based conservation plan, update the county’s comprehensive land use plan, and comply with the ESA. The plan directs growth to areas with the least natural, historic, and cultural resource values as well as sets aside sensitive habitat through land acquisitions. As of 2006 the county had built a conservation land reserve of 77,000 acres. (Pima County, 2006b)

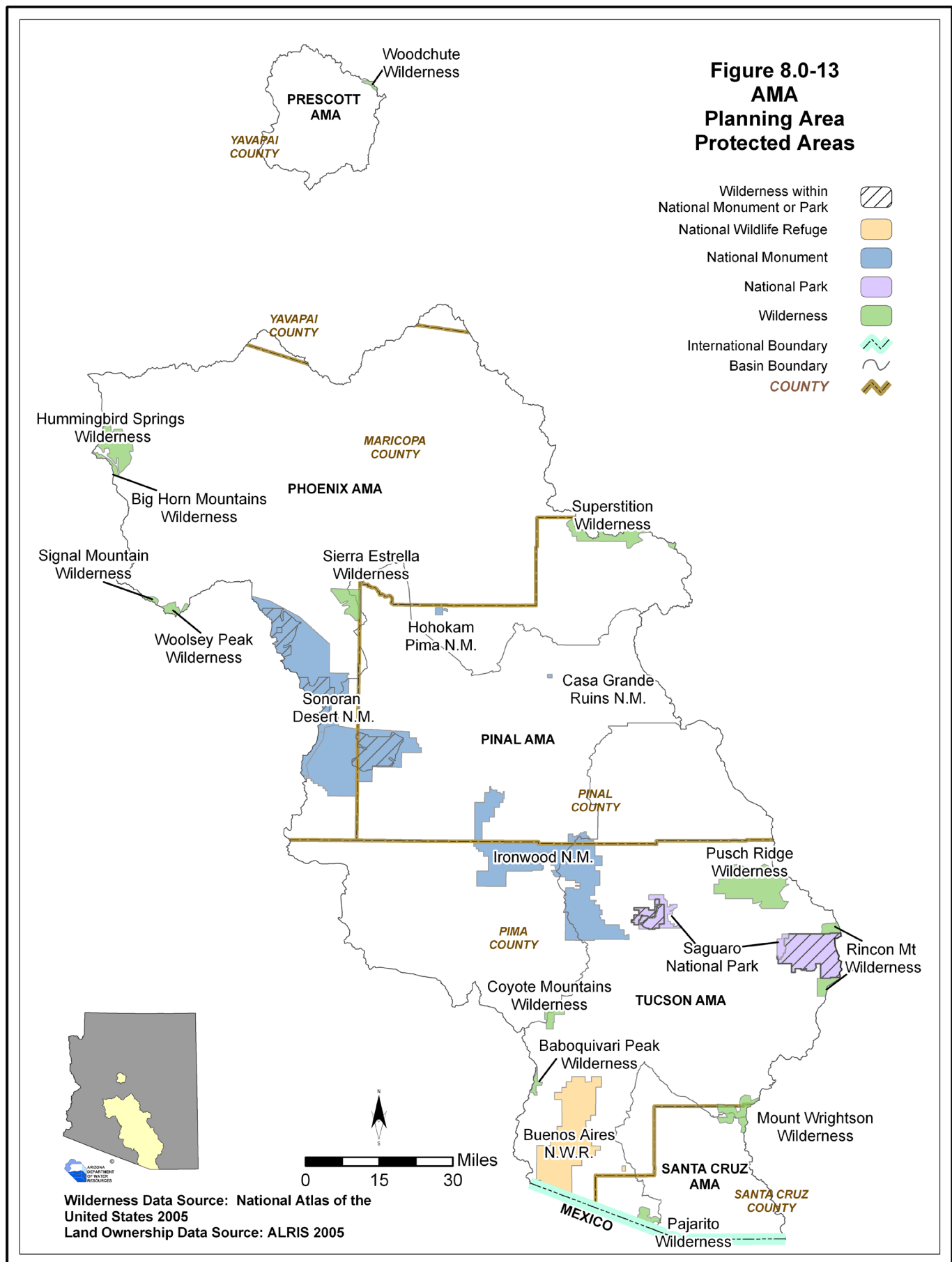
National Parks, Monuments, Wildlife Refuges and Wilderness Areas

The AMA Planning Area contains eleven Wilderness Areas administered by the Bureau of Land Management (BLM), five by the National Forest Service (USFS) and one administered by the National Park Service. The Planning Area also includes one National Wildlife Refuge (NWR), one National Park and four National Monuments (Figure 8.0-13). The national park and one national monument also contain wilderness areas. In total there are over 823,000 acres of protected federal lands in the planning area, accounting for approximately 9% of the land area. The Tucson AMA contains the largest amount of protected areas with almost 372,000 acres.

² An “endangered species” is defined by the USFWS as “an animal or plant species in danger of extinction throughout all or a significant portion of its range,” while a “threatened species” is “an animal or plant species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

³ As defined by the ESA, to take means to “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in other conduct” (16 U.S.C. section 1531[18])

⁴ “Incidental take” is defined by the ESA as a take that is “incidental to, and not the purpose of, the carrying out of an otherwise lawful activity” (50 C.F.R. section 17.22 and 17.32).



Nine wilderness areas are entirely within the planning area as well as parts of eight others. Wilderness Areas are designated under the 1964 Wilderness Act to preserve and protect the designated area in its natural condition. Designated wilderness areas, their size, basin location and a brief description of the area are listed in Table 8.0-3.

The largest protected area in the planning area consists of approximately 259,000 acres of the 496,000-acre Sonoran Desert National Monument. The monument, located in the Phoenix and Pinal AMAs, was established by executive proclamation in 2001 and contains extensive areas of saguaro cactus forest and archeological and historic sites. Two wilderness areas are contained within the monument boundaries. (BLM, 2008)

The Ironwood Forest National Monument, located in the center of the planning area in the Tucson and Pinal AMAs, includes over 129,000 acres. An additional 60,000 acres of state trust land and private inholdings are contained within the boundary of the monument but do not have national monument status. Designated in 2000, several endangered and threatened species are found in the monument as well as more than 200 sites dating from the Hohokam period (600 A.D. to 1440 A.D.). (BLM, 2008)

Other national monuments in the AMA Planning Area include the Hohokam Pima National Monument in the Phoenix AMA, and the Casa Grande Ruins National Monument in the Pinal AMA. Both national monuments protect ancient Hohokam ruins. The village at the Hohokam Pima National Monument, located on the Gila River Indian Community reservation, was re-covered with earth in the 1960s and is not open to the public (NPS, 2008a). Casa Grande Ruins National Monument was created as the nation's first archeological reserve in 1892 and was declared a national monument in 1918. The monument preserves the ancient farming community and its "Great House" (NPS, 2008b). Tumacácori National Historical Park, located in the Santa Cruz AMA, protects three Spanish colonial mission ruins: Tumacácori, Guevavi, and Calabazas, located at three separate sites. Mission San Jose de Tumacacori was established in 1691 and is the main site, located on 310 acres at the town of Tumacácori south of Tubac.

The only national park in the planning area, Saguaro National Park, preserves over 83,000 acres in two distinct districts, the Rincon Mountain District and the Tucson Mountain District. The park is located on the east and west sides of Tucson in the Tucson AMA. Saguaro National Park is thought to be home to ten species of threatened, endangered, or sensitive plants. Seventy-five percent of the park is designated as wilderness. (NPS, 2008c)

The Buenos Aires National Wildlife Refuge, located in the Tucson AMA, contains over 118,000 acres of habitat for threatened and endangered plants and animals including reintroduced populations of masked bobwhite quail and pronghorn antelope. Concerns about public safety have caused managers to close approximately 3,500 acres of this NWR to the public along the U.S./Mexico border. (USFWS, 2008)

Table 8.0-3 Wilderness areas in the AMA Planning Area

Wilderness Area	Acres in the Planning Area	AMA	Description
Baboquivari Peak	2,738	Tucson	Includes Baboquivari Peak; oak, walnut, and pinyon at higher elevations and saguaro, paloverde, and chaparral at lower elevations.
Big Horn Mountains	3,082 (Partial)	Phoenix	Desert plain escarpments, hills, fissures, chimneys and narrow canyons.
Coyote Mountains	4,483	Tucson	Rugged peaks, rounded bluffs, sheer cliff faces and large open canyons with paloverde, saguaro, chaparral, and oak woodlands.
	1,309	Pinal	
Hummingbird Springs	24,453 (Partial)	Phoenix	Includes Sugarloaf Mountain which rises steeply from the Tonopah Desert plains.
Mount Wrightson	10,322	Tucson	Deep canyons, ridges and peaks surrounded by semiarid hills and sloping grasslands. Ponderosa pine, douglas-fir and montane Mexican plants that grow nowhere else north of the border.
	5,542	Santa Cruz	
North Maricopa Mountains*	24,353 (Partial)	Phoenix	Low-elevation Sonoran Desert mountain range and extensive surrounding desert plains.
Pajarito	7,553	Tucson	Includes narrow Sycamore Canyon and Sycamore Creek with rolling hills and oak woodlands.
Pusch Ridge	56,769	Tucson	Pine, fir, aspen, and maple forests; elevation ranging from 2,800 feet to over 9,100 feet.
Rincon Mountain	11,127	Tucson	Desert grasses at the lower elevations and steep hillsides of pinyon, juniper, and oak above deep canyons at higher elevations.
Saguaro*	68,399	Tucson	Vegetation varies with elevation and includes desert scrub, desert grassland, oak woodland, pine-oak woodland, pine forest and mixed conifer forest.
Sierra Estrella	11,715	Phoenix	Steep slopes and rocky canyons with diverse plant communities.
	3,041	Pinal	
Signal Mountain	1,830 (Partial)	Phoenix	Sharp volcanic peaks, steep-walled canyons, arroyos, craggy ridges and outwash plains.
South Maricopa Mountains*	21,331 (Partial)	Phoenix	Low-elevation Sonoran Desert mountain range and extensive surrounding desert plains.
Superstition	22,179 (Partial)	Phoenix	Rugged mountains, rock formations, large vegetation range, prehistoric dwellings, riparian habitat.
Table Top	34,715	Pinal	Includes Table Top Mountain with a 40-acre summit of desert grassland, narrow ridges, wide canyons, lava flows, and washes lined with mesquite and ironwood.
Woodchute	1,411 (Partial)	Prescott	Views, ponderosa pine, pinyon and juniper.
Woolsey Peak	4,913 (Partial)	Phoenix	Sloping lava flows, basalt mesas, rugged peaks and ridges.
Total	321,539		

Sources: BLM 2008, USFS 2008, NPS 2008c

* Wilderness areas are within the boundaries of a National Monument or National Park

8.0.5 Population

Population in the planning area has rapidly increased over the last few decades. Between 1990 and 2000 the population in the AMA Planning Area increased by 38%; population increased an additional 25% between 2000 and 2006. Census data for 2000 show a population of approximately 4.1 million residents and Arizona Department of Economic Security (DES) population projections suggest that the planning area population will more than double by 2030. Historic, current and projected AMA populations are shown in the cultural water demand tables for each AMA in Sections 8.1 - 8.5.

The most populous AMA is the Phoenix AMA with approximately 75% of the total planning area population in 2000. The Tucson AMA has the second largest percentage of population in the planning area with 20% in 2000. The 2000 Census populations for each AMA and Indian reservations are shown in Table 8.0-4.

AMA population is growing rapidly as Arizona was the second fastest growing state from 2000 to 2006, with a 20.2% population increase. Almost all AMAs experienced growth rates in excess of the state average. During this time period Prescott AMA population increased by 29%, Phoenix AMA population increased by 25% and the Pinal AMA population grew by 68%. The Tucson AMA population increased at a lower rate of 19% during this period.

Table 8.0-4 2000 Census population of AMAs and Indian reservations

AMA/Reservation	2000 Census Population
Phoenix AMA	3,056,706
<i>Gila River</i>	7,855
<i>Fort McDowell Yavapai</i>	929
<i>Salt River Pima-Maricopa</i>	6,243
Tucson AMA	811,307
<i>Pascua Yaqui</i>	3,315
<i>Tohono O'odham</i>	2,034
Pinal AMA	93,580
<i>Ak-Chin</i>	752
<i>Gila River</i>	3,435
<i>Tohono O'odham</i>	3,016
Prescott AMA	85,742
<i>Yavapai-Prescott</i>	183
Santa Cruz AMA	35,579
Total	4,082,914

In the Santa Cruz AMA, population increased by 22% mostly in unincorporated areas. While the City of Nogales population growth rate has remained nearly constant at approximately 0.71% per year, the growth rate in the unincorporated areas of the AMA has risen from approximately 6.3% per year during the 1990s to 8.1% per year in the period between 2000 and 2006. The total population estimate for the unincorporated communities exceeded that of the City of Nogales for the first time in 2006.

Table 8.0-5 Communities in Active Management Areas with a Census population greater than 1,000 (listed by 2000 population)

Communities	Basin	1990 Census Pop.	2000 Census Pop.	Percent Change 1990-2000	2006 Pop. Estimate	Percent Change 2000-2006	Projected 2030 Pop.
Phoenix	Phoenix AMA	983,392	1,321,045	34%	1,505,265	14%	2,201,843
Tucson	Tucson AMA	405,371	486,699	20%	534,685	10%	671,225
Mesa	Phoenix AMA	288,104	396,375	38%	451,360	14%	584,866
Glendale	Phoenix AMA	147,864	218,812	48%	243,540	11%	322,062
Scottsdale	Phoenix AMA	130,075	202,705	56%	237,120	17%	286,020
Chandler	Phoenix AMA	89,862	176,581	97%	235,450	33%	283,792
Tempe	Phoenix AMA	141,993	158,625	12%	165,890	5%	197,970
Gilbert	Phoenix AMA	29,122	109,697	277%	185,030	69%	300,295
Peoria	Phoenix AMA	50,675	108,364	114%	145,135	34%	306,070
Avondale	Phoenix AMA	16,169	35,883	122%	72,210	101%	123,265
Prescott	Prescott AMA	26,592	33,938	28%	42,085	24%	68,099
Apache Junction	Phoenix AMA	18,092	31,814	76%	35,685	12%	113,928
Surprise	Phoenix AMA	7,122	30,848	333%	98,140	218%	401,458
Oro Valley	Tucson AMA	6,670	29,700	345%	40,215	35%	60,344
Casa Grande	Pinal AMA	19,076	25,224	32%	38,455	52%	114,613
Prescott Valley	Prescott AMA	8,904	23,535	164%	35,740	52%	73,737
Nogales	Santa Cruz AMA	19,489	20,878	7%	21,765	4%	26,356
Fountain Hills	Phoenix AMA	10,030	20,235	102%	24,990	23%	33,810
Goodyear	Phoenix AMA	6,258	18,911	202%	49,720	163%	299,397
Florence	Pinal AMA	7,321	14,466	98%	21,295	47%	63,791
Paradise Valley	Phoenix AMA	11,773	13,664	16%	14,000	2%	15,352
Marana	Tucson AMA	2,187	13,556	520%	30,435	125%	89,761
Eloy	Pinal AMA	7,211	10,375	44%	11,535	11%	40,571
Buckeye	Phoenix AMA	4,436	8,497	92%	31,745	274%	419,146
Chino Valley	Prescott AMA	4,837	7,835	62%	12,700	62%	30,286
Coolidge	Pinal AMA	6,934	7,786	12%	9,950	28%	37,609
El Mirage	Phoenix AMA	5,001	7,609	52%	32,605	329%	38,717
South Tucson	Tucson AMA	5,171	5,490	6%	5,805	6%	5,675
Guadalupe	Phoenix AMA	5,458	5,228	-4%	5,570	7%	5,983

Table 8.0-5 Communities in Active Management Areas with a Census population greater than 1,000 (cont)

Communities	Basin	1990 Census Pop.	2000 Census Pop.	Percent Change 1990-2000	2006 Pop. Estimate	Percent Change 2000-2006	Projected 2030 Pop.
Tolleson	Phoenix AMA	4,434	4,974	12%	6,520	31%	10,193
Queen Creek	Phoenix AMA	2,667	4,316	62%	18,690	333%	72,947
Litchfield Park	Phoenix AMA	3,303	3,810	15%	4,890	28%	10,510
Cave Creek	Phoenix AMA	2,925	3,728	27%	4,865	30%	9,656
Superior	Phoenix AMA	3,468	3,254	-6%	3,325	2%	4,249
Sahuarita	Tucson AMA	1,629	3,242	99%	18,035	456%	84,714
Youngtown	Phoenix AMA	2,542	3,010	18%	6,320	110%	7,359
Carefree	Phoenix AMA	1,657	2,927	77%	3,785	29%	6,097
Maricopa	Pinal AMA	-	1,482	N/A	25,830	1643%	90,521
Dewey - Humboldt	Prescott AMA	-	-	N/A	4,230	N/A	6,082
Total > 1,000		2,487,814	3,575,118	44%	4,434,610	24%	7,518,369
Other		466,829	507,796	9%	651,364	28%	1,099,742
Total		2,954,643	4,082,914	38%	5,085,974	25%	8,618,111

Source: DES 2005, US Census Bureau 2006

Shown in Table 8.0-5 are communities in the planning area with 2000 Census populations greater than 1,000 persons and growth rates for two time periods: 1990-2000 and 2000-2006. As shown, there are a number of rapidly growing communities in the planning area. The community of Maricopa in the Pinal AMA grew 1,643% between 2000 and 2006. The community of Marana in the Tucson AMA grew 520% between the years 1990 and 2000 and an additional 125% from 2000 to 2006. Many other communities in the planning area have grown by several hundred percentage points during one or both time periods. Gilbert, Surprise and Goodyear, all in the Phoenix AMA, grew by more than 200% between 1990 and 2000. The Town of Prescott Valley in the Prescott AMA grew by 164% in the same time period.

Population Growth and Water Use

A variety of regulatory programs and local initiatives affect water use in conjunction with growth within the AMAs. Three examples at the state level that affect multiple AMAs include the Assured Water Supply Program, Growing Smarter legislation, and Community Water System Planning. Locally, communities and counties may have programs or requirements that address growth and water use through impact fees, zoning, planning guidelines and ordinances. Ordinances may include water conservation features in new construction and landscape restrictions; information on these ordinances may be obtained by contacting local planning and zoning departments.

In the Tucson AMA, the Sonoran Desert Conservation Plan was initiated by Pima County in

1998 in response to conservation needs of rare species, and as an effort to balance growth and environmental concerns. The 50-year plan covers 59 million acres within Pima County. The SDCP was incorporated into Pima County's comprehensive land use plan in 2001 and addresses issues such as land use and water availability.

The Groundwater Code established within each AMA a five-member Groundwater Users Advisory Council (GUAC). Members of the councils are appointed by the governor to represent the users of groundwater in the AMA, and on the basis of their knowledge, interest, and experience with problems relating to the development, use and conservation of water. The GUACs provide recommendations on groundwater management programs and policies to the AMA area director, and to the Director of the Department.

A number of citizen-based advocacy groups, and government-sponsored advisory groups, also provide input into the growth and water use decision-making process within the AMA Planning Area. These groups may include municipal and regional water users associations; watershed groups; county water advisory councils; non-profit conservation groups; water augmentation authorities; and county associations of government.

Assured Water Supply Program

The Department's Assured Water Supply (AWS) program, created as part of the 1980 Groundwater Management Code, is designed to preserve groundwater resources and to promote long-term water supply planning in the AMAs. This is accomplished through regulations that limit the use of groundwater by new subdivisions that require a "Certificate" of AWS and by "Designated" Water Providers that have demonstrated an AWS for their entire service area. The AWS Program also provides consumer protection by requiring developers to demonstrate that sufficient water supplies are available for new subdivisions prior to sale.

Every developer proposing to build a new subdivision is required to demonstrate an AWS that will be physically, legally, and continuously available for the next 100 years before the developer can record plats or sell parcels. The Arizona Department of Real Estate will not issue a Public Report, which allows the developer to sell lots, without a demonstration of an AWS.

In 1995, the Department adopted AWS Rules to implement the AWS statutes. An important component of the AWS Rules is the requirement to demonstrate that renewable water supplies will be used rather than mined groundwater. This requirement did not apply to the Prescott AMA until 1999 when the AMA was declared to no longer be in a safe-yield condition.

The Santa Cruz AMA was established July 1, 1994 near the end of the period when the AWS Rules were being drafted. Consequently, it was not possible to include rule provisions that applied to the management goal of the Santa Cruz AMA at that time since goal criteria had not been developed. Although the general Rule provisions apply, the Department is still developing specific AWS Rules for the Santa Cruz AMA where relatively limited groundwater storage capacity directly influences the availability of water supplies and where the hydrologic situation may affect the course of population growth in this AMA.

Table 8.0-6 Designated water providers in the AMA Planning Area

Water Provider Name	Active Management Area	County	Designation No.	Date Application Received	Date Designation Issued	Projected or Annual Estimated Demand (af/yr)	Year of Projected or Annual Estimated Demand
Apache Junction Water Facility	Phoenix	Pinal	26-400989.0000	06/09/03	02/01/05	2,769	2011
Chapparal City Water Company	Phoenix	Maricopa	26-401242.0000	02/11/04	04/07/04	8,000	2014
City of Avondale	Phoenix	Maricopa	86-002003.0001	06/11/07	02/04/08	21,186	2010
City of Chandler	Phoenix	Maricopa	26-002009.0000	02/15/95	12/31/97	63,615	2010
City of El Mirage	Phoenix	Maricopa	26-400054.0000	03/22/99	11/02/99	7,695	2010
City of Glendale	Phoenix	Maricopa	26-002018.0000	03/15/95	09/25/97	57,074	2010
City of Goodyear	Phoenix	Maricopa	26-402090.0000	04/07/06	01/27/08	15,940	2010
City of Mesa	Phoenix	Maricopa	26-002023.0000	05/28/96	09/19/97	105,061	2010
City of Peoria	Phoenix	Maricopa	26-400679.0000	01/18/02	10/17/02	39,325	2010
City of Phoenix	Phoenix	Maricopa	26-002030.0000	10/11/96	12/31/97	356,521	2010
City of Scottsdale	Phoenix	Maricopa	26-400619.0000	10/11/01	04/25/02	105,986	2008
City of Surprise	Phoenix	Maricopa	26-300431.0000	11/11/97	09/07/99	20,334	2010
City of Tempe	Phoenix	Maricopa	26-002043.0000	03/27/97	12/31/97	70,462	2010
Johnson Utilities	Phoenix	Pinal	26-400665.0000	12/26/01	08/12/03	5,633	2011
Town of Gilbert	Phoenix	Maricopa	26-402208.0000	06/19/06	10/30/07	70,954	2010
City of Casa Grande	Pinal	Pinal	26-400728.0000	05/06/02	07/21/03	4,113	2013
City of Eloy	Pinal	Pinal	26-402148.0000	05/10/06	02/20/07	49,159	2015
Johnson Utilities	Pinal	Pinal	26-401382.0000	05/26/04	10/14/05	551	2007
Santa Cruz Water Company	Pinal	Pinal	26-402008.0000	01/24/06	12/27/07	23,979	2013
Town of Florence	Pinal	Pinal	26-401284.0000	03/12/04	01/25/05	12,310	2014
City of Prescott	Prescott	Yavapai	26-401501.0000	09/02/04	09/16/05	14,350	2014
Baca Float Water Company, Inc.	Santa Cruz	Santa Cruz	26-400800.0000	08/13/02	11/17/04	333	2011
City of Nogales	Santa Cruz	Santa Cruz	26-401358.0000	05/14/04	04/19/05	6,322	2009
City of Tucson	Tucson	Pima	26-400957.0000	04/29/03	06/12/07	183,956	2015
Marana Municipal Water System	Tucson	Pima	26-402254.0000	07/31/06	05/07/07	7,580	2017
Metropolitan Domestic Water Imp. Dist. - West	Tucson	Pima	26-401922.0000	10/20/05	09/25/06	1,014	2016
Metropolitan Domestic Water Improvement District	Tucson	Pima	26-401062.0000	09/02/03	07/31/06	13,302	2016
Sahuarita Water Company	Tucson	Pima	26-401203.0000	01/06/04	12/01/04	2,578	2014
Spanish Trail WC	Tucson	Pima	26-000170.0000	07/18/97	04/16/96	1,843	2005
Town of Oro Valley	Tucson	Pima	26-400765.0000	07/01/02	06/26/03	15,049	2013
Vail Water Company	Tucson	Pima	26-401752.0000	05/03/05	11/10/05	3,749	2015
Willow Springs Utilities Company	Tucson	Pinal	26-402225.0000	07/06/06	04/15/08	2,635	2017

Following adoption of the AWS Rules, rapid population growth in the Pinal AMA led to modification of the AMA's AWS Rules in order to reduce the over allocation of groundwater supplies. This rule change, which took effect on October 1, 2007, substantially reduced the volume of groundwater that can be used without replenishment by new developments, from close to 100% under the old rules to as little as 10% under the new rules.

Under the AWS Rules, the developer can prove a 100 year water supply by satisfying the requirements to obtain a Certificate of AWS or by a written commitment of service from a provider with a Designation of AWS. The AWS Rules list in detail what an applicant for a Certificate of AWS or a Designation of AWS must demonstrate. In addition to securing a water supply that is physically, legally, and continuously available for the next 100 years, the developer, in order to obtain a Certificate, must prove that the supply is of sufficient quality and is consistent with the AMA management goal and management plan. Finally, the developer must demonstrate the financial capability to construct any necessary water storage, treatment, and delivery systems. Water providers seeking a Designation of AWS must demonstrate a 100-year water supply for their entire service area for both current and committed demand, as well as projected demand. A list of current Designated water providers in the planning area can be found in Table 8.0-6.

Before the AWS program was created in 1980, the Adequate Water Supply program was effective statewide. This program was created in 1973 as a consumer protection program and is still in effect outside the AMAs. If a developer can successfully demonstrate that water of sufficient quality will be physically, legally and continuously available for the next hundred years, the Department will issue a Water Adequacy Report with a determination that the water supply is adequate. If the Department determines that there is an inadequate water supply, the developer can still sell the lots but must disclose this fact to potential buyers. Because the Adequate Water Supply program was in effect in the planning area prior to 1980, some Water Adequacy Reports issued for older developments in the AMAs exist.

Prior to obtaining a Certificate of AWS, developers also have the option to obtain an Analysis of AWS (Analysis). An Analysis is generally used to prove that water will be physically available for master planned communities but may be used to demonstrate other criteria required for a Certificate of AWS. An applicant for an Analysis must demonstrate that one or more of the requirements for an AWS are met, but need not demonstrate that all have been met. If an Analysis is issued for groundwater, it reserves a specific volume of water for 10 years for the specific property that is the subject of the Analysis. However, an Analysis cannot be used to obtain a Public Report and must be followed by a complete demonstration of all the criteria to obtain a Certificate of AWS.

A summary of the planning area's AWS determinations including AWS Certificates (27's), Analysis of AWS (28's), Water Adequacy Reports (53's) and AWS Designations (26's) can be found in Table 8.0-7. Detailed information on individual subdivisions are found in the AMA Assured Water Supply sections, 8.1.9- 8.5.9.

Growing Smarter

Four out of the five counties in the planning area have requirements under the Growing Smarter Plus Act of 2000 (GSP Act). The GSP Act requires that counties with a population greater than 125,000

Table 8.0-7 Assured Water Supply determinations in the AMA Planning Area

	AWS Certificates	Analysis of AWS	Water Adequacy Reports	AWS Designations
<i>Phoenix AMA</i>	865	18	196	15
<i>Pinal AMA</i>	192	18	16	5
<i>Prescott AMA</i>	104	2	9	1
<i>Santa Cruz AMA</i>	34	6	32	2
<i>Tucson AMA</i>	201	4	90	9
Total	1396	48	343	32

Note: Totals do not include change of ownership or re-issuance of AWS Certificates

(2000 Census) include planning for water resources in their Comprehensive Plans. Counties in the planning area that must meet this requirement are Maricopa, Pinal, Pima and Yavapai. Santa Cruz is the only county in the planning area with a population less than 125,000 residents.

The GSP Act also requires that 30 communities in the AMAs include a water resources element in their general plan. These communities are:

Phoenix AMA	Apache Junction
	Avondale
	Buckeye
	Cave Creek
	Chandler
	El Mirage
	Fountain Hills
	Gilbert
	Glendale
	Goodyear
	Mesa
	Paradise Valley
	Peoria
	Phoenix
	Queen Creek
	Scottsdale
Pinal AMA	Surprise
	Tempe
	Casa Grande
	Eloy
Prescott AMA	Florence
	Maricopa City
	Chino Valley
	Prescott
Santa Cruz AMA	Prescott Valley
	Nogales
Tucson AMA	Marana
	Oro Valley
	Sahuarita
	Tucson

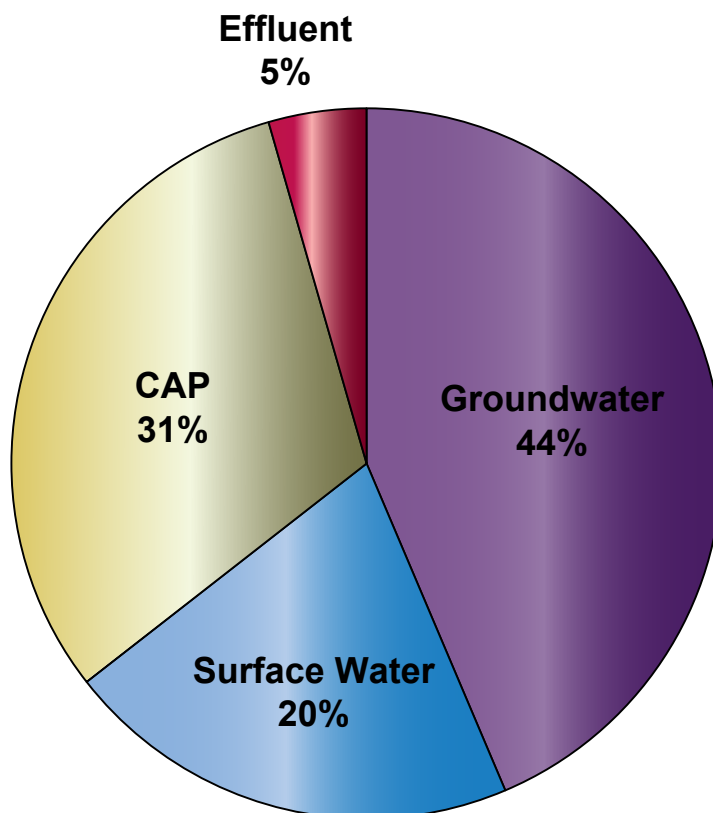
As of December, 2007, all but Nogales had complied with the general plan requirement. Plans must consider water demand and water resource availability in conjunction with growth, land use and infrastructure. These plans may contain useful water resource information.

Community Water System Planning

Beginning in 2007, all community water systems in the state are required to submit annual water use reports and system water plans to the Department. The reports and plans are intended to reduce community water systems' vulnerability to drought, and to promote water resource planning to ensure that water providers are prepared to respond to water shortage conditions. Community water systems located within the AMA Planning Area have been reporting their annual water use to the Department and have been regulated under the Department's mandatory municipal conservation program since the early 1980s. They are now subject to the system water plan requirements, though exemptions from some components of the plans may apply for large municipal providers, as well as providers with an AWS designation.

The Department is working to establish local drought impact groups (LDIGs) throughout the state. LDIGs are county-level groups that will coordinate drought preparedness at the local level. They are led by the county extension agent and county emergency manager, and have three main objectives: collect and report drought impact information, coordinate drought public awareness, and develop and implement local mitigation and response options. Participants include municipal and private water providers, irrigation districts, tribal governments, local non-governmental organizations, state/federal agencies, and other interested citizens. LDIGs have been established in Cochise, Yavapai, Santa Cruz, Pinal, Pima, Graham, Greenlee, and Navajo Counties. Formation of LDIGs in the remaining counties are planned for 2008-2009.

Figure 8.0-14 Water supply utilized in the AMA Planning Area



8.0.6 Water Supply

Water supplies in the AMA Planning Area include Central Arizona Project (CAP) water, surface water, groundwater and effluent. As shown in Figure 8.0-14, on average more than half of the annual water demand in the planning area from 2001-2003 was met with non-groundwater supplies. Non-groundwater or renewable supplies in the planning area are comprised mainly of CAP water and surface water diverted from the Salt, Verde, Gila, Agua Fria or Santa Cruz rivers. Effluent is also a growing non-groundwater source used in the planning area. Non-groundwater supplies were the primary water supply source in the Pinal and Phoenix AMAs between 2001-2003. In the Pinal AMA,

53% of the average annual water demand between 2001-2003 was met with a non-groundwater source and 47% of the demand was met with groundwater. The Phoenix AMA also relies heavily on non-groundwater sources. 62% of its average annual demand in 2001-2003 was met with non-groundwater sources and 38% of its demand was met with groundwater.

In 2001-2003, an average of 45% of the planning area water demand was met with groundwater. The Prescott AMA used solely groundwater supplies with the exception of small amounts of effluent during this period. The Santa Cruz AMA uses a combination of groundwater, and surface water from the younger alluvium that is withdrawn from wells and collectively considered groundwater. Between 2001 and 2003, the Tucson AMA used approximately 73% groundwater and 27% non-groundwater supplies to meet demands. The percentage of non-groundwater sources, primarily CAP, used in the Tucson AMA has increased rapidly over the last five years due to the increased recharge and recovery capacity in the municipal sector.

Central Arizona Project Water

The primary non-groundwater source in the planning area is CAP water. The CAP was constructed to annually deliver 1.5 maf of Arizona's allocation of Colorado River water to Pima, Pinal and Maricopa counties through a series of canals and pumping stations. (See Figure 8.0-15) The project is 336 miles long and lifts Colorado River water 2,400 feet to its final destination just south of the City of Tucson. Water is withdrawn at Lake Havasu at the Mark Wilmer Pumping Plant. It then crosses the Parker, Ranegras Plain and Harquahala basins via the Hayden-Rhodes Aqueduct to the CAP service area in central and southern Arizona.

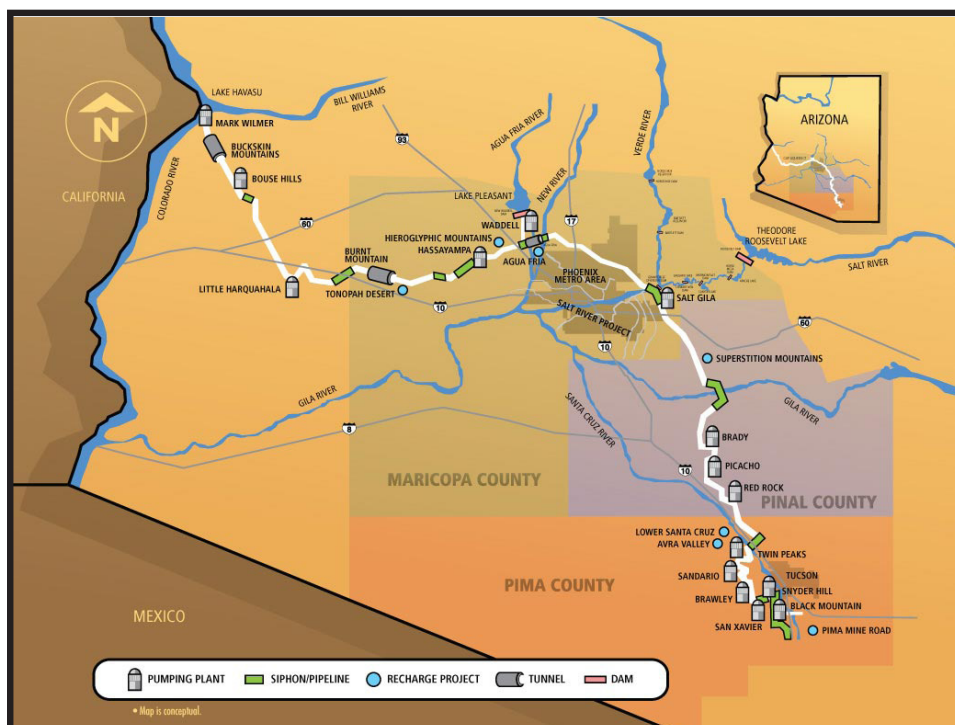


Figure 8.0-15 Central Arizona Project system map

(Source: CAP, 2008)

The CAP canal enters the planning area on the western side of the Phoenix AMA and runs toward the east and southeast across much of the AMA. A significant portion of CAP water is stored in Lake Pleasant behind New Waddell Dam at the northern edge of the Phoenix AMA. It then travels in a southerly direction and enters the Pinal AMA north of Florence, crosses the northeastern portion of the AMA and enters the Tucson AMA near Picacho Peak. The CAP canal terminates at Pima Mine Road in the Tucson AMA just south of the San

Xavier District of the Tohono O'odham Nation. Turnouts from the CAP aqueduct connect it to municipal water treatment plants and irrigation district canals for distribution. CAP water is used both directly and

indirectly through the Department's recharge program, in the Phoenix, Pinal and Tucson AMAs. CAP was first used in the planning area in 1985.

There are three main CAP user categories: municipal and industrial (M&I), non-Indian agricultural and Indian. Almost all non-Indian agricultural subcontracts have been declined or terminated and CAP water is used pursuant to the Department's recharge program discussed below. The status of CAP subcontracts as of March 2008 is found in Appendix B. According to the status report, subcontract totals were:

M&I Subcontracts	620,678 acre-feet
Indian Contracts	555,806 acre-feet
Non-Indian Agricultural Subcontracts	9,026 acre-feet
Currently Uncontracted Water	155,787 acre-feet
Other Under Contract	73,703 acre-feet

To encourage the direct use of renewable water supplies, the recharge program restricts the type of water that may be stored long-term to renewable sources that cannot be used directly. Persons who wish to store water through the recharge program must apply to the Department for permits. There are two types of facilities and associated permits; Underground Storage Facility (USF) Permits and Groundwater Savings Facility (GSF) Permits. In addition, a Water Storage (WS) Permit (A.R.S. § 45-831.01) allows the permit holder to store water at a USF or a GSF and a Recovery Well (RW) Permit (A.R.S. § 45-834.01) allows the permit holder to recover long-term storage credits or to recover stored water annually.

CAP water use on non-Indian agricultural land is pursuant to GSF Permits (A.R.S. § 45-812.01), which allows the permit holder to deliver a renewable water supply, called "in lieu" water, to a recipient (farm) who agrees to replace groundwater pumping with in lieu water, thus creating a groundwater savings. The permit holder accrues recharge credits which can be recovered later from a well elsewhere in the AMA (or INA). When withdrawn, the water retains the character of the water that was recharged at the GSF.

A USF Permit (A.R.S. § 45-811.01) allows the permit holder to operate a facility that stores water in the aquifer in one of two ways. A constructed underground storage permit allows water to be stored by using some type of constructed device, such as an injection well or percolation basin. A managed underground storage facility permit allows water to be discharged to a naturally water-transmissive area such as a streambed where the water percolates into the aquifer without the assistance of a constructed device.

Most of the water delivered to recharge facilities in the AMA Planning Area is CAP water with lesser amounts of effluent and surface water. In 2005, over 423,000 acre-feet of CAP water, 91,600 acre-feet of effluent and 11,400 acre-feet of surface water was delivered to USFs and GSFs, for a total of over 526,000 acre-feet delivered. As of 2005, more than 3.7 maf of long term storage credits had been accrued in the AMA Planning Area. The location of GSF and USF sites and facility information is shown on maps and tables in the groundwater conditions section for each AMA.

Surface Water

In addition to CAP water, the principal sources of surface water in the planning area are the Salt and Verde rivers. Most of this water is appropriated to shareholders of the Salt River Valley Water Users Association or Salt River Project (SRP). The SRP was established in 1903 as the nation's first multipurpose reclamation project. Today, it is the nation's third largest public power utility and one of the state's largest water suppliers. Working with other agencies, the SRP manages or assists with the management of seven dams. This reservoir system is utilized in conjunction with about 250 groundwater wells to provide water through 131 miles of canal to a 2,900 square mile service area that delivers more than 1 maf of water annually to its customers.. The SRP encompasses portions of the East Salt River Valley and West Salt River Valley sub-basins in the Phoenix AMA, including portions of Glendale, Peoria, Phoenix, Scottsdale, Tempe, Tolleson, Chandler, Gilbert, and Mesa. (SRP, 2008) Historically SRP water was used predominantly for agricultural irrigation; now a large portion of the project's service area is urbanized. In addition to the SRP, the Roosevelt Water Conservation District and the Buckeye Water Conservation District use surface water from the Salt and Verde rivers.

The Gila River is also an important water supply in both the Phoenix and Pinal AMAs where it is used primarily for agricultural irrigation. Water is diverted for the San Carlos Irrigation Project (SCIP) at Ashurst-Hayden Diversion Dam located 12 miles east of Florence in the Pinal AMA. The dam, completed in 1922, consists of diversion works and is not a storage or flood control facility. Diverted water is conveyed to the San Carlos Irrigation and Drainage District (SCIDD), located in the Pinal AMA, consisting of approximately 200 miles of unlined main and lateral canals and 40 miles of canals owned jointly with the SCIP (ADWR, 1998). In addition to agricultural uses, SCIDD delivers Gila River water mixed with groundwater for landscape irrigation to subdivisions, schools, parks, Casa Grande, Coolidge and Florence (ADWR, 1999b). The SCIP also delivers Gila River water to tribal lands within the Gila River Indian Community located in the Phoenix and Pinal AMAs. The Buckeye Water Conservation and Drainage District in the West Salt River Sub-basin of the Phoenix AMA also uses Gila River water as part of its water supply.

Maricopa Water District (MWD) in the West Salt River Valley Sub-basin uses a combination of CAP and Agua Fria River water stored in Lake Pleasant behind New Waddell Dam, which was completed in 1992. This water is delivered to the MWD service area via the 33-mile Beardsley Canal. MWD owned and operated Waddell Dam, the original storage and flood control structure on the Agua Fria River, which was breached and inundated by the enlarged Lake Pleasant. (ADWR, 1998)

A few additional sources of surface water are utilized in the planning area. Santa Cruz River water is diverted for agricultural irrigation by the Central Arizona Irrigation and Drainage District in the Eloy Sub-basin of the Pinal AMA. In the Tucson AMA, surface water diverted from Cienega Creek is used for turf irrigation at Del Lago Golf Course at Vail and springs are the water supply for the community of Summerhaven, located in the Santa Catalina Mountains.

In the Prescott AMA, the City of Prescott has acquired surface water rights to water stored at Watson Lake and Willow Creek reservoirs from the Chino Valley Irrigation District (CVID). Under the agreement the City maintains the lakes for recreational purposes and releases approximately 1,500

acre-feet per year for recharge, which it recovers on an annual basis. As part of the agreement the City of Prescott annually provides up to 1,500 acre-feet of recovered effluent credits to CVID members for irrigation. While the City of Prescott holds surface water rights to water stored at Lynx and Upper Goldwater reservoirs, this water is not used as a water supply.

Groundwater

Groundwater is an important water supply in the planning area. It is the primary water source in the Prescott and Santa Cruz AMAs, as these AMAs do not have access to CAP water. Water supplies are managed jointly as “groundwater” in the Santa Cruz AMA due to the close hydrologic relationship of surface water, groundwater and effluent. Up until relatively recently, the Tucson AMA also relied primarily on groundwater to meet demand. Groundwater is also a vital water supply for the Phoenix and Pinal AMAs, although currently, surface water supplies surpass groundwater supplies in both AMAs. Groundwater is a relatively abundant water supply with maximum well yields in all five AMAs exceeding 4,000 gpm.

As a result of long term groundwater pumping in the AMAs, moderate to severe regional and localized water level declines have occurred. Over time, groundwater declines can lead to increased pumping costs, decrease in water quality, riparian damage, land subsidence and land fissuring, all of which have occurred in the planning area. In the last two decades localized groundwater level rises have also occurred at some locations. Localized water level rises are primarily due to retirement of agricultural lands, use of CAP water in lieu of groundwater and a growing number of underground storage projects.

All groundwater used in the AMAs is currently pumped from within the AMAs. The Groundwater Transportation Act of 1991 restricts the transportation of groundwater from non-AMA groundwater basins to AMAs; however, there are a few exceptions. Specific statutes allow the transportation of groundwater from the Butler Valley, Harquahala and McMullen Valley basins and the Big Chino sub-basin into AMAs. For example, the City of Phoenix owns 14,000 acres of agricultural land in the McMullen Valley Basin allowing it to transport up to 6 maf of groundwater into the Phoenix AMA. The City of Scottsdale has also applied to the Department to transport 3,645 acre-feet of groundwater per year from historically irrigated land in the Harquahala Basin.

Groundwater transportation from the Big Chino Sub-basin of the Verde River Basin, northwest of the Prescott AMA, represents the largest source of alternative water supply currently available for municipal water users within the Prescott AMA. Under A.R.S. § 45-555(E), the City of Prescott may withdraw an amount not to exceed 14,000 acre-feet per year. The Director has issued an advisory opinion that the amount that may be withdrawn by the City of Prescott is 8,717 acre-feet; however, a final determination has not been made. No water may be withdrawn for transportation into the AMA pursuant to this statute until the Director has made a final determination. Additionally, the statute allows for cities and towns to withdraw groundwater associated with historically irrigated acres (HIA) for transportation into the Prescott AMA. The Department will make a determination regarding the volume of water that can be transported from HIA lands after an application in submitted by a city or town. In general, the allotment associated with HIA is 3 acre-feet per acre per year.

In order to improve available groundwater supply information, the Department has established automated groundwater monitoring sites that record water levels in wells. This information is available through an interactive map on the Department's website (www.azwater.gov/dwr/). These devices are generally placed in areas that the Department wishes to monitor closely, such as areas of growth, subsidence and areas affected by drought. Currently there are 70 monitoring sites in the planning area: 34 in the Phoenix AMA; 16 in the Prescott AMA; 11 in the Tucson AMA; five in the Santa Cruz AMA; and four in the Pinal AMA. Index well hydrographs, which display historic water level conditions, are available through an interactive map on the same website for 830 wells in the planning area.

Information on major aquifers, well yields, estimated natural recharge, aquifer flow direction, and water level changes are found in groundwater data tables, groundwater condition maps, hydrographs and well yield maps for each AMA in Sections 8.1.6 through 8.5.6.

Effluent

Effluent, also referred to as reclaimed water, is a growing non-groundwater supply in the AMA Planning Area, accounting for approximately 5% of the annual supply during the 2001-2003 time period. Since effluent production is tied directly to population, population growth generally leads to increased effluent supply. However, lack of infrastructure to deliver effluent to potential users is often a limiting factor. The Phoenix and Tucson AMAs generate the majority of the effluent in the planning area, which is used by agricultural, municipal and industrial sectors.

Many municipalities, as well as private entities in the planning area, recharge effluent in permitted basins and streambeds. This storage in turn earns the entity recharge credits that it can either pump from the ground at a later date through a permitted recovery well, or use towards assured water supply certificates or designations. The option of recharge is often favored by entities as a way of using the effluent if direct use is not possible due to the lack of a distribution system.

There is increasing interest in effluent as a water supply as growth continues and other renewable water sources become more extensively used. Some utilities, for example Tucson Water, Phoenix, Prescott and Scottsdale, have made substantial investments in effluent reuse. Recently, Global Water Resources, a private water and wastewater utility, is promoting reuse technology at new development in Maricopa where its water center uses non-potable water for irrigation and toilet flushing.

Most of the effluent in the Phoenix AMA is generated at the 91st Avenue WWTP. The treatment plant processes approximately 139,000 acre-feet of wastewater annually from much of Glendale, Mesa, Phoenix, Scottsdale, and Tempe, who co-own the facility as part of a multi-city partnership known as SROG, the Sub-regional Operating Group. A large portion of the effluent is used at the Palo Verde Nuclear Generating Station for cooling purposes. Unused effluent from the plant is discharged into the Salt and Gila Rivers, supporting perennial flow and flowing out of the AMA. Effluent is also a water supply for agricultural irrigation. Effluent generated from Phoenix's 23rd Avenue WWTP is used to irrigate crops in the Roosevelt Irrigation District and effluent from Chandler's Lone Butte WWRP is used for irrigation on the Gila River Indian Reservation. In addition to industrial and agricultural uses, effluent is used for landscape and golf course watering.

Major cities in the Phoenix AMA and the City of Tucson in the Tucson AMA have extensive distribution systems for delivery of reclaimed wastewater to golf courses, parks and schools.

In the Pinal AMA, Casa Grande, Coolidge, Eloy and Florence all have municipal WWTPs. These plants deliver treated effluent for a variety of purposes, including agricultural irrigation, golf course watering, and power generation. Florence and Eloy also have permitted underground storage facilities for recharging effluent. The City of Maricopa's wastewater needs are handled by a private utility and the effluent is used for watering turf and filling subdivision lakes. There are several other WWTPs serving unincorporated communities. Effluent from these facilities is used for golf course watering, and in some cases the excess is recharged at underground storage facilities (see Table 8.2-7).

Effluent is an important water supply in the Tucson AMA where it meets approximately 3% of the total AMA water demand. The City of Tucson operates an extensive reclaimed water system that has been in operation since the early 1980s. The system consists of almost 160 miles of pipe, 33 mgd of production capacity, 15 million gallons of storage capacity and four supply sources including the Tucson Water Reclaimed Water Treatment Plant, a treatment wetlands and a managed underground storage facility. The system extends throughout the Tucson water service area and extends into northeast Marana near the Tortolita Mountains and interconnects to the Oro Valley system where it is used for golf course irrigation in the Town of Oro Valley. Reclaimed water is delivered to approximately 900 sites in the Tucson Water service area including 14 golf courses, 35 parks, 46 schools and more than 700 single family homes. (Tucson Water, 2007)

Three communities in the Prescott AMA have permitted recharge facilities that receive effluent: the City of Prescott, the Town of Prescott Valley and the Town of Chino Valley. Effluent availability at the Town of Chino Valley is currently limited as the Town is largely unsewered. However it is in the process of constructing a centralized sewer system to serve new and existing developments. Effluent is a source of supply both directly and through recharge and recovery for three golf courses, a community park, and a sand and gravel operation in Prescott, as well as for a golf course at Prescott Valley. Effluent stored by the City of Prescott is recovered by CVID for agricultural irrigation. Effluent stored by Prescott Valley is not currently recovered.

The Nogales International Wastewater Treatment Plant (NIWWTP) is the primary treatment facility in the Santa Cruz AMA. It treats over 16,000 acre-feet of sewage from both Nogales, Arizona and Nogales, Sonora, which is currently discharged to the Santa Cruz River. Several smaller "package" treatment plants provide treatment to developments within the AMA, but do not provide a significant amount of useable effluent.

Contamination Sites

Sites of environmental contamination may impact the use of some water supplies. An inventory of Department of Defense (DOD), Resource Conservation and Recovery Act (RCRA), Superfund, Water Quality Assurance Revolving Fund (WQARF), Voluntary Remediation Program (VRP) and Leaking Underground Storage Tank (LUST) sites was conducted for the planning area. Table 8.0-8 provides a summary of contamination sites, by cleanup program, for each AMA. Tables listing the

contaminant and affected media as well as maps showing the location of all contamination sites can be found in the AMA Water Quality sections.

Table 8.0-8 Contamination sites in the AMA Planning Area

AMA	Leaking Underground Storage Tanks	Voluntary Remediation Program	Resource Conservation and Recovery Act	Department of Defense	Water Quality Assurance Revolving Fund	Superfund
Phoenix	4,042	39	9	1	12	4
Pinal	292	3	1	NA	NA	NA
Prescott	180	3	NA	NA	NA	NA
Santa Cruz	26	1	1	NA	NA	NA
Tucson	1,157	15	2	1	7	1
Total	5,697	61	13	2	19	5

Sources: ADEQ 2002, ADEQ 2006

In the AMA Planning Area there are 61 active VRP sites. The majority (39) of these sites are located in the Phoenix AMA. The VRP is a state administered and funded voluntary cleanup program. Any site that has soil and/or groundwater contamination, provided that the site is not subject to an enforcement action by another program, is eligible to participate. To encourage participation, ADEQ provides an expedited process and a single point of contact for projects that involve more than one regulatory program (Environmental Law Institute, 2002).

There are 14 RCRA sites in the AMA Planning Area, 10 in the Phoenix AMA, two in the Tucson AMA and one each in the Pinal and Santa Cruz AMAs. The RCRA program regulates the management of hazardous waste handlers which includes generators, transporters and facilities for treatment, storage and disposal (ADEQ, 2002). The sites listed in Table 8.0-8 and in the AMA Water Quality sections are RCRA corrective action sites where contamination of groundwater and/or soil has occurred due to improper handling of hazardous waste.

Two DOD sites are located in the AMA Planning Area, the 161st Air National Guard site in the Phoenix AMA and the Davis-Monthan Air Force Base site in the Tucson AMA. DOD sites listed in the AMA Water Quality sections are contamination sites that are located at active duty bases, bases being closed under the Base Realignment and Closure regulations or Formerly Used Defense sites that are eligible for funding under the Installation Restoration Program overseen by ADEQ (ADEQ, 2008).

There are 19 WQARF sites and five Superfund sites in the AMA Planning Area. These sites are located in the Phoenix and Tucson AMAs. WQARF is a state administered funding mechanism created to support hazardous substance cleanup efforts. Superfund is the federal government's program, administered by the Environmental Protection Agency (EPA), to clean up the most contaminated hazardous waste sites across the country. (ADEQ, 2008) Almost all WQARF and Superfund sites in the planning area involve Trichloroethylene (TCE) and/or Tetrachloroethene (PCE) contamination. One Superfund site, 19th Avenue Landfill in the Phoenix AMA, was removed from the National Priorities List (NPL) of Superfund sites in 2006 after the EPA and ADEQ determined that no further cleanup activities were necessary (ADEQ, 2006).

There are 5,697 active LUST sites in the planning area. Four thousand and forty-two sites are located in the Phoenix AMA, 292 in the Pinal AMA, 180 in the Prescott AMA, 26 in the Santa Cruz AMA and 1,157 in the Tucson AMA.

8.0.7 Cultural Water Demand

Total cultural water demand in the AMA Planning Area averaged approximately 3,750,800 acre-feet per year during the 2001-2003 time period; approximately 52% of the total demand in Arizona. Total non-Indian and Indian demand, by water source and water demand sector for each AMA, is shown in Figure 8.0-16 and Table 8.0-9. Tribal demand and non-Indian municipal, agricultural and industrial sector demand are discussed later in this section. Tribal and non-tribal demands are discussed separately because non-Indian water use in AMAs is regulated under the Groundwater Code which requires annual reporting of water use by all groundwater rightholders, compliance with mandatory conservation requirements, and other regulations. As a consequence, these data are generally reported in Departmental and other publications.

As shown in Figure 8.0-16, cultural water demands vary widely between the AMAs due to differences in geographic area, population, land use and available water supplies. Total cultural water demand is the highest in the Phoenix AMA and lowest in the Santa Cruz AMA with an average annual total demand of 2,335,200 acre-feet and 23,800 acre-feet, respectively.

Municipal demand accounted for 34% of the cultural water demand with approximately 1,258,200 acre-feet of average annual demand during the 2001-2003 time period. Municipal demand includes water delivered by a water provider and water withdrawn from domestic (exempt) wells.⁵ As would be expected, the Phoenix AMA accounts for the largest (81%) of the total municipal demand in the planning area. Across the AMAs, 61% of the municipal demand is met with CAP, surface water and effluent supplies. As with the agricultural sector, this source of supply differs between AMAs. The Phoenix AMA meets over 71% of its municipal demand with CAP, surface water and effluent supplies while the other AMAs use primarily groundwater.

The agricultural sector is the highest demand sector with 2,211,000 acre-feet or approximately 59% of the total cultural demand. Agricultural demand exists within all AMAs but the volumes vary significantly between them. The largest annual average agricultural demand is in the Phoenix AMA at 1.1 maf (47% of total Phoenix AMA demand) and the smallest is in the Prescott AMA with 6,100 acre-feet (25% of total Prescott AMA demand). The sources of water used to meet demand also vary between the AMAs. Agricultural demand in the Prescott AMA is met with groundwater and recovered effluent credits; surface water use has recently ceased. In the Phoenix and Pinal AMAs, more than half of the agricultural demand is met with CAP, surface water and effluent supplies. In Tucson, approximately 27% of the agricultural demand is met with CAP water and the remainder by groundwater.

Industrial demand accounted for the remaining 7% of the annual cultural water demand within the planning area for the 2001-2003 time period. Although groundwater is the predominant water supply for industrial uses in all AMAs, significant volumes of effluent are used in the Phoenix and

⁵ An exempt well is a well having a pump capacity of not more than thirty-five gallons per minute. Within an AMA, a person may withdraw groundwater from an exempt well for a non-irrigation use without a groundwater right or permit.

**Figure 8.0-16
AMA Water Demand by
Sector and Water Source
Avg. 2001-2003**

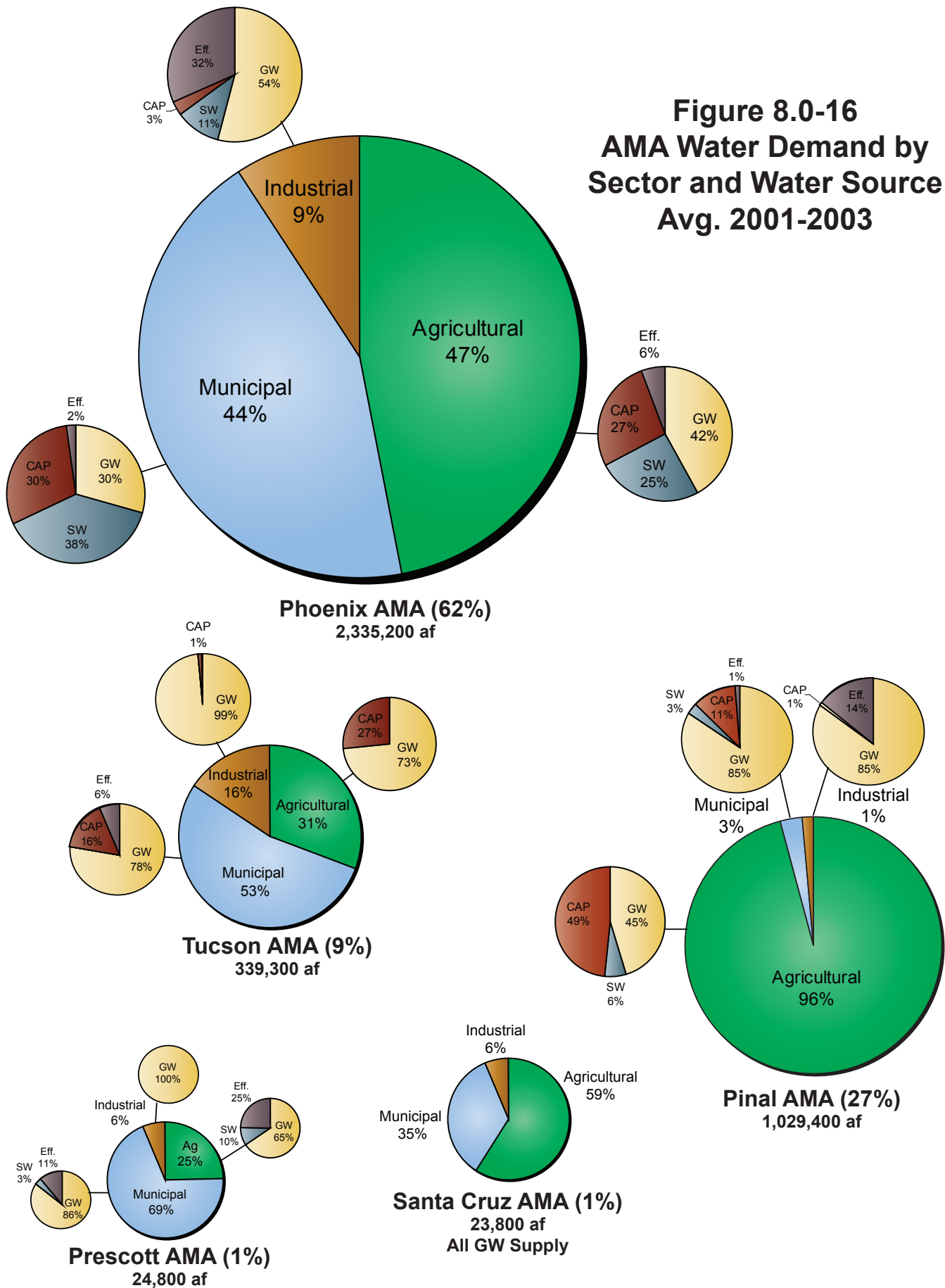


Table 8.0-9 AMA water demand by sector and water source (Indian and Non-Indian) avg. 2001-2003

Phoenix AMA

	Groundwater	Surface Water	CAP	Effluent	Total
Municipal	298,200	392,800	302,000	21,600	1,014,600
Non-Indian	7,900	200	0	0	8,100
Indian	306,100	393,000	302,000	21,600	1,022,700
Total					
Industrial					0
Non-Indian	115,700	23,400	7,100	67,400	213,600
Indian	115,700	23,400	7,100	67,400	213,600
Total					0
Agricultural	388,100	168,900	266,100	65,000	890,200 ¹
Non-Indian	73,100	108,900	26,900	0	208,900
Indian	461,200	277,800	293,000	65,000	1,097,000
Total	883,000	694,200	602,100	154,000	2,333,300
Grand Total					

Prescott AMA²

	Groundwater	Surface Water	Effluent	Total
Municipal	14,800	600	1,900	17,300
Industrial	1,500	0	0	1,500
Agricultural	4,000	600	1,500	6,100
Grand Total	20,300	1,200	3,400	24,900

Santa Cruz AMA²

	Groundwater
Municipal	8,300
Industrial	1,500
Agricultural	14,000
Grand Total	23,800

Pinal AMA

	Groundwater	Surface Water	CAP	Effluent	Total
Municipal	22,600	800	3,000	400	26,800
Non-Indian	1,100	0	0	0	1,100
Indian	23,700	800	3,000	400	27,900
Total					
Industrial	11,900	0	100	2,000	14,000
Non-Indian	11,900	0	100	2,000	14,000
Indian	383,800	52,100	409,700	1,600	847,200
Non-Indian	60,600	6,100	73,500	0	140,200
Indian	444,400	58,200	483,200	1,600	987,400
Total	480,000	59,000	486,300	4,000	1,029,300
Grand Total					

Tucson AMA

	Groundwater	Surface Water	CAP	Effluent	Total
Municipal	141,600	80	28,700	11,600	181,980
Non-Indian	200	0	0	0	200
Indian	141,800	80	28,700	11,600	182,180
Total					
Industrial	50,600	0	500	200	51,300
Non-Indian	1,400	0	0	0	1,400
Indian	52,000	0	500	200	52,700
Total					
Agricultural	76,600	0	16,800	0	93,400
Non-Indian	0	0	11,000	0	11,000
Indian	76,600	0	27,800	0	104,400
Total	269,000	80	57,000	11,800	337,880
Grand Total					

Total All AMAs

	Groundwater	Surface Water	CAP	Effluent	Total
Municipal	485,500	394,280	333,700	35,500	1,248,980
Non-Indian	9,200	200	0	0	9,400
Indian	494,700	394,480	333,700	35,500	1,258,380
Total					
Industrial	181,200	23,400	7,700	69,600	281,900
Non-Indian	1,400	0	0	0	1,400
Indian	182,600	23,400	7,200	69,600	282,800
Total					
Agriculture	866,500	221,600	692,600	68,100	1,848,800
Non-Indian	133,700	115,000	111,400	0	360,100
Indian	1,000,200	336,600	804,000	68,100	2,208,900
Total	1,677,500	754,480	1,144,900	173,200	3,750,080
Grand Total					

Pinal AMAs. The nature of the industrial demand differs between the AMAs. Water use by turf-related facilities is the largest industrial demand in the Santa Cruz, Prescott and Phoenix AMAs. In the Tucson AMA, mining accounts for almost 70% of the industrial demand. In the Pinal AMA, dairies and feedlots are the largest industrial demand category, accounting for 47% of the industrial total.

Tribal Water Demand

With the exception of the Santa Cruz AMA, there are tribal lands within all AMAs. Tribal communities, in alphabetical order, are: Ak-Chin Indian Community (Pinal AMA); Fort McDowell Yavapai Nation (Phoenix AMA); Gila River Indian Community (Phoenix and Pinal AMAs); Pascua Yaqui Tribe (Tucson AMA); Salt River Pima-Maricopa Indian Community (Phoenix AMA); Tohono O’odham Nation (Pinal and Tucson AMAs); and Yavapai-Prescott Indian Tribe (Prescott AMA). Annual tribal demand is approximately 371,100 acre-feet per year. Ninety seven percent of tribal demand is agricultural irrigation. Groundwater meets about 39% of all tribal demand with large proportions of surface water (31%) and CAP water (30%) also utilized.

Ak-Chin Indian Community

The Ak-Chin Indian Community is a 21,480-acre area located entirely within the Pinal AMA in northwest Pinal County approximately 50 miles south of the Phoenix metropolitan area. The community has approximately 750 tribal members comprised of both the Tohono O’odham and Pima people (2000 Census). The community includes a 109-acre industrial park and 15,000 acres of irrigated fields (ITCA, 2008). Additionally, in 1994, the Ak-Chin Community entered into a management agreement to construct the Harrah’s Phoenix Ak-Chin Casino located within the community.

The Ak-Chin Indian Community was originally allocated 58,300 acre-feet of CAP water in 1983. Pursuant to the community’s water rights settlement in 1984, it is entitled to 75,000 acre-feet of Colorado River water in a normal year, 85,000 acre-feet in a surplus year and not less than 72,000 acre-feet in a shortage year. The intended use of the CAP water is irrigation (CAP, 2008). In addition to on-reservation use of CAP water, the Ak-Chin Indian Community has entered into long term CAP lease agreements, primarily with Anthem. In 2007, approximately 7,000 acre-feet of CAP lease water was used by off-reservation users.

Fort McDowell Yavapai Nation

The almost 25,000-acre Fort McDowell Yavapai reservation is located in northeastern Maricopa County approximately 23 miles northwest of Phoenix. The reservation is bisected by the Verde River and is located entirely within the Phoenix AMA. The Nation has slightly more than 900 members comprised of the Yavapai and Apache people (2000 Census). There are a number of commercial operations within the reservation. The Fort McDowell Casino is a gaming facility located adjacent to a 247-room Radisson Resort and Conference Center and the 18-hole We-Ko-Pa Golf Club. Fort McDowell Yavapai Materials is a sand and gravel facility that has been in operation since 1980. The Fort McDowell Tribal Farm includes 2,000 irrigated acres of alfalfa, pecans and citrus.

Recreational activities associated with the Verde River and Fort McDowell Adventures are other tribal enterprises (NAU, 2008; ITCA, 2008).

The Fort McDowell Yavapai Nation was originally allocated 4,300 acre-feet of CAP water in 1983. Pursuant to the tribe's water rights settlement in 1990, the nation now has 18,233 acre-feet of CAP allocation with the intended use identified as tribal homeland (CAP, 2008). In 2007, the City of Phoenix executed a long-term lease of 4,300 acre-feet/year of the Fort McDowell Yavapai Nation entitlement.

Gila River Indian Community

The 373,000-acre Gila River Indian Community (GRIC) reservation straddles the Phoenix and Pinal AMAs, occupying lands on both sides of the Gila River south of Phoenix, Tempe, and Chandler. It is inhabited by 14,000 people of the Pima and Maricopa tribes (ITCA, 2008), with approximately 11,300 inhabitants within the planning area. Industrial parks, gaming facilities and agriculture are the primary demand sectors. There are three industrial parks and a business park that occupy more than 800 acres of developable land. The agricultural industry brings more than \$25 million of annual income to the GRIC in the form of 15,000 irrigated acres of GRIC farms and 22,000 independently farmed acres that produce cotton, wheat, millet, alfalfa, barley, melons, pistachios, olives, citrus and vegetables (ITCA, 2008). The Wild Horse Pass Casino and Vee Quiva collectively form the Gila River Casinos. The Sheraton Wild Horse Pass Resort and Spa includes a 17,500 square foot spa, two 18-hole golf courses, an equestrian center, and a 2½ mile long replica of the Gila River with scenic boat rides (NAU, 2008; ITCA, 2008).

The GRIC was originally allocated 173,100 acre-feet/yr of CAP water for irrigation purposes in 1983. An additional 138,700 acre-feet/yr were allocated to the GRIC pursuant to the Arizona Water Settlement Act (Act) bringing their total CAP allocation to 311,800 acre-feet/yr (CAP, 2008). The Act and a subsequent settlement agreement specify the water rights assigned to the GRIC. The GRIC have rights to 13 categories of water including CAP, surface water, effluent and groundwater. In addition to CAP water, supplies include 125,000 acre-feet/yr of Globe Equity Decree Water (Gila River water) and 156,700 acre-feet of groundwater. In total, the GRIC are entitled to an estimated average of 653,500 acre-feet/yr for any period of ten consecutive years. In 2004, the GRIC pumped or received about 217,000 acre-feet of water. Ninety-eight percent of the demand was for agriculture. (ADWR, 2006b) The Community is in the planning stages of a large irrigation project with plans to establish an irrigation system to deliver water to 146,300 acres of land in seven reservation districts (GRIC, 2008). While up to 41,000 acre-feet/yr of Indian priority CAP water has been approved for lease to Phoenix AMA cities by the Tribal Council, no leases have been executed.

Pascua Yaqui Tribe

The Pascua Yaqui Tribe is composed of nine communities located in the Tucson, Phoenix and Pinal AMAs. The largest in terms of population is New Pascua, consisting of 1,152 acres of trust land located about 15 miles southwest of Tucson. New Pascua is recognized as the Pascua Yaqui reservation. The second largest community is Guadalupe located in the Town of Guadalupe southeast of Phoenix. Other communities in the Tucson AMA are: Old Pascua near downtown Tucson; Barrio Libre in the Town of South Tucson and Yoem Pueblo in Marana. Other communities in the

Phoenix AMA are Penjamo in Scottsdale and High Town in Chandler. Pinal AMA communities are located at Coolidge and Eloy (Pascua Yaqui Tribe, 2005).

There are 3,315 members of the Pascua Yaqui tribe at New Pascua (2000 Census), but many tribal members live off the reservation in other communities in the planning area and also outside of Arizona. According to the Pascua Yaqui Tribe, in July 2005 there were almost 7,700 tribal members in the nine communities with a total Arizona population of approximately 13,100 (Pascua Yaqui Tribe, 2005). There is no irrigated acreage on the Pascua Yaqui Tribe reservation and the land dedicated to development of an industrial park currently remains vacant (NAU, 2008). There are two gaming facilities on the reservation and the 4,400 seat Anselmo Valencia Tori Amphitheater is southern Arizona's largest concert venue. The Pascua Yaqui tribe holds a CAP allocation for tribal homeland uses of 500 acre-feet/yr (CAP, 2008).

Salt River Pima-Maricopa Indian Community

The Salt River Pima-Maricopa Indian Community (SRPMIC) is located entirely within the Phoenix AMA adjacent to the cities of Scottsdale, Fountain Hills, Mesa, Tempe and Phoenix. The lands within the 56,000-acre reservation have been allocated for different uses including agriculture, industrial and commercial use with the remaining acres reserved for recreation, housing and desert preservation (NAU, 2008). There are more than 6,200 members on the reservation representing the Pima and Maricopa tribes (2000 Census). There are 13,000 acres of irrigated lands with the primary crops being cotton, melons, potatoes, onions and carrots. Commercial land use is largely restricted to lands that bound Pima Road and the primary commercial use is a 140-acre retail center, "The Pavilions". Other industrial uses include Cypress Golf Course (two nine-hole courses), Talking Stick Golf Club (a 36-hole course), a sand and gravel operation and a 200-acre landfill. There are two gaming facilities on the reservation, the Casino Arizona at McKellips and the Casino Arizona at Talking Stick. The SRPMIC holds a CAP allocation for irrigation use of 13,300 acre-feet/yr (CAP, 2008). The SRPMIC has executed long-term leases of CAP water to the cities of Gilbert (4,088 acre-feet/yr), Chandler (2,586 acre-feet/yr), Glendale (1,814 acre-feet/yr), Mesa (1,669 acre-feet/yr), Scottsdale (60 acre-feet/yr) and Tempe (60 acre-feet/yr).

Tohono O'odham Nation

The 2.8 million acre Tohono O'odham Nation is comprised of four separate reservations. The largest reservation, Tohono O'odham, is located within both the Pinal and Tucson AMAs and tribal lands extend south into Mexico. The Gila Bend Reservation (San Lucy District) is outside of the planning area in the Gila Bend Basin. The 71,095-acre San Xavier Reservation is located south of Tucson within the Tucson AMA. The smallest reservation is the 20-acre Florence Village located 2 miles west of Florence in the Pinal AMA. There are almost 24,000 members of the Nation with just over 5,000 members within the planning area. Industrial uses within the Nation include a 120-acre industrial park located within the San Xavier District of the Tohono O'odham Reservation. The Nation operates two casinos in the planning area, both located south of Tucson; the Desert Diamond I-19 Casino and the Desert Diamond Casino.

The entire Tohono O'odham Nation holds a 74,000 acre-foot CAP allocation. The Southern Arizona Water Rights Settlement Act (SAWRSA) of 2004 (Title III of the Arizona Water Settlements Act) and the subsequent settlement agreement specified that the Nation was entitled to 79,200

acre-feet of water rights within the Tucson AMA for use on the San Xavier Reservation and the Eastern Schuk Toak District. Of this total, 66,000 acre-feet is CAP water and 13,200 acre-feet is groundwater. Both San Xavier and Schuk Toak have recently started large-scale irrigation projects. In 2005, more than 13,300 acre-feet of CAP water was used primarily for agricultural irrigation on these lands. (ADWR, 2006c) The Nation may lease up to 15,000 acre-feet of CAP water to off-reservation users.

Yavapai-Prescott Indian Tribe

The Yavapai-Prescott Indian Tribe reservation is approximately 1,400 acres located within the City of Prescott in the Prescott AMA. The reservation has approximately 180 members (2000 Census) of the Yavapai-Prescott Indian Tribe. Historical land uses included timber, mining and ranching, however, current tribal uses are business oriented. The tribe operates the 12-acre Sundog Industrial Park and the 250-acre Frontier Village shopping center. There are two gaming facilities on the reservation; the Yavapai Bingo and Gaming Center and Bucky's Casino with the adjacent 160-room Prescott Resort and Conference Center (ITCA, 2008; NAU, 2008). The Yavapai-Prescott Tribe received an original allocation of 500 acre-feet of CAP water that was relinquished in 1994 by the tribe pursuant to its water rights settlement and acquired by the City of Scottsdale in 1996 (CAP, 2008). Currently, the tribe is provided water by the City of Prescott, although they retained up to 1,000 acre-feet of annual surface water rights from Granite Creek.

Municipal Demand

Municipal, non-Indian demand is summarized by AMA and water supply in Table 8.0-10. Average annual demand during the 2001-2003 time period was almost 1.25 maf. Throughout the planning area, approximately 39% of the municipal demand is met with groundwater, 31% with surface water, 27% with CAP water and 3% with effluent (see Table 8.0-10). However, different supplies are utilized to meet municipal demand among the AMAs. The Phoenix AMA is unique in that it meets over 68% of its municipal demand with surface water from the CAP and the Salt and Verde river systems. Groundwater is the primary municipal water supply in the Pinal and Tucson AMAs. The Tucson AMA uses effluent to meet 6% of its municipal demand, the largest percentage of any AMA.

Table 8.0-10 Average annual municipal water demand in the AMA Planning Area (2001-2003)

Basin	Groundwater	Surface Water	CAP	Effluent	Total
Phoenix AMA	298,200	392,800	302,000	21,600	1,014,600
Pinal AMA	22,600	800	3,000	400	26,800
Prescott AMA	14,800	600	0	1,900	17,300
Santa Cruz AMA	8,300	0	0	0	8,300
Tucson AMA	141,600	80	28,700	11,600	181,980
Total Municipal	485,500	394,280	333,700	35,500	1,248,980

Notes: Does not include Indian municipal use

Within the Santa Cruz AMA, water is not separately defined as surface water or groundwater, therefore all volumes are reported as groundwater.

Municipal supplies in the Prescott AMA are primarily groundwater, and smaller volumes of effluent and surface water. All of the water supplies in the Santa Cruz AMA are considered groundwater.

A total of 52 water providers within the planning area each served more than 1,000 acre-feet of water, excluding effluent, in 2003 (see Table 8.0-11). Of these largest water providers, 33 are located in the Phoenix AMA and met 85% of the Phoenix AMA potable municipal demand. The 11 largest water providers in the Tucson AMA met 93% of the AMA's potable municipal demand. In the other AMAs, the largest water providers met between 72% and 76% of the AMA's potable municipal demand in 2003.

Water providers fall primarily into two categories: public water systems or private water companies. Private water companies are regulated by the Arizona Corporation Commission (ACC), which oversees setting water rates in these service areas. Publically owned systems are not regulated by the ACC and have the authority to enact water conservation ordinances and establish water rates as approved by the appropriate governing body. This authority may provide greater flexibility to manage water resources within their water service areas.

There are regulatory requirements for water providers within AMAs. Under the conservation programs in the AMA Management Plans, ADWR regulates water providers that annually serve more than 250 acre-feet of water for non-irrigation use as large municipal water providers. The Groundwater Code expressly mandates that these conservation programs require reasonable reductions in per capita water use through time and implementation of conservation measures designed to reduce water use within the service area. The Code also requires that reasonable conservation requirements be established for small municipal water providers.

Golf Course Demand

Golf courses within the planning area used approximately 125,000 acre-feet of water in 2006 (See Table 8.0-12). Each AMA within the planning area has golf course demand; however, there are significant differences in the number of golf courses within each AMA and the sources of water used to supply them.

Pursuant to the Groundwater Code, water provided directly to a golf course by a water provider is categorized as municipal use and is calculated as part of the overall municipal demand. Groundwater that is withdrawn by the facility itself, through its own wells, is categorized as industrial use. Data from both municipal and industrial golf courses are shown in Table 8.0-12. Additionally, some golf courses receive effluent, surface water and CAP, either through direct delivery or via recovery of stored water, and these volumes may or may not be calculated within a water provider's deliveries. Other unique situations also exist. For example, in the Santa Cruz AMA, the Palo Duro Golf Course receives water from municipal wells but it also receives remediated poor-quality water from the United Musical Instruments RCRA remediation site.

Table 8.0-11 Water providers serving a minimum of 1,000 acre-feet of water annually (excluding effluent) in the AMA Planning Area

Water Provider	1990 (AF)	2000 (AF)	2003 (AF)	Water Provider	1990 (AF)	2000 (AF)	2003 (AF)
Phoenix AMA							
City of Phoenix	268,598	304,743	329,711	City of El Mirage	1,686	3,360	4,666
City of Mesa	71,023	101,461	100,458	Johnson Utilities Company	N/A	N/A	4,062
City of Scottsdale	43,317	79,479	77,901	City of Tolleson	1,477	2,920	3,594
City of Tempe	50,748	63,236	57,668	Queen Creek Water Company	669	2,063	3,502
City of Chandler	24,433	61,500	57,256	Town of Buckeye	662	1,094	2,601
City of Glendale	33,484	45,660	48,149	City of Goodyear	1,030	1,189	2,520
Town of Gilbert	7,838	30,070	37,743	Rio Verde Utilities, Inc.	1,173	2,711	2,450
City of Peoria	10,691	23,514	20,898	New River Utility Company	7	983	1,862
Arizona-American Water Co. - Sun City System	13,271	13,076	14,601	Turner Ranches Water and Sanitation Company	1,068	2,669	1,842
City of Avondale	3,072	6,392	11,931	Apache Junction Facilities District	761	1,611	1,821
Arizona-American Water Co. - Paradise Valley System	8,369	11,069	11,034	Luke Air Force Base	1,622	1,701	1,524
Arizona Water Co. - Apache Junction System	3,725	10,627	10,983	City of Surprise		821	1,515
Litchfield Park Service Company	1,940	3,982	7,144	Cave Creek Water Company	736	1,406	1,437
Arizona-American Water Co. - Agua Fria System	841	4,952	7,237	Rose Valley Water Company	114	915	1,376
Chaparral City Water Company	2,716	6,363	7,152	Berneil Water Company	729	1,194	1,229
Arizona-American Water Co. - Sun City West System	4,269	6,250	5,981	Carefree Water Company	1,281	1,000	1,071
Pima Utilities Company	3,274	5,526	5,832				
Pinal AMA							
Arizona Water Co. - Casa Grande System	7,381	10,411	13,540	Arizona Water Co. - Coolidge System	1,305	1,646	1,647
City of Eloy	2,223	2,211	2,206	Town of Florence	797	1,999	1,547
Prescott AMA							
City of Prescott	5,014	6,614	6,948	Prescott Valley Water District	1,795	3,912	4,342
Santa Cruz AMA							
City of Nogales	4,529	4,375	4,235	Rio Rico Utilities	678	1,756	2,092
Tucson AMA							
City of Tucson	95,519	117,656	123,852	Community Water Co. of Green Valley	1,713	2,243	2,525
Town of Oro Valley (formerly Canada Hills Water Co.)	2,731	9,085	10,233	University of Arizona	1,631	1,516	1,514
Metro Domestic Water Improvement District	7,190	8,642	9,002	Metro Water District - Hub	872	1,105	1,126
Flowing Wells Irrigation District	2,646	2,879	2,865	Avra Water Co-op	534	1,027	1,076
Lago Del Oro Water Co.	422	2,220	2,586	Davis-Monthan Air Force Base	1,755	1,423	1,073
Green Valley Water Co.	1,918	2,225	2,497				

Phoenix AMA

For the 2001-2003 time period, the annual municipal demand in the Phoenix AMA, excluding Indian demand, averaged 1,014,600 acre-feet. Municipal water demand has become the AMA's major non-Indian demand sector and is steadily growing. Approximately 61% of the municipal demand is located within the cities of Phoenix, Mesa, Scottsdale, Tempe, and Chandler. In addition to public and private water companies, water for municipal use, including urban irrigation, is provided by water districts and water users associations. These include SRP, Roosevelt Water Conservation District (RWCD), Buckeye Water Conservation and Drainage District and Roosevelt Irrigation District. The largest by far is SRP which operates an extensive water delivery system that includes portions of Glendale, Peoria, Phoenix, Scottsdale, Tempe, Chandler, Gilbert and Mesa. Its eight canals deliver Salt

and Verde river water, supplemented by groundwater, to municipal and agricultural users. It also wheels other kinds of water, including CAP water, through its system. In addition to providing untreated water for urban irrigation, the system is connected to eight municipal water treatment plants for delivery of potable water through municipal water systems.

Table 8.0-12 Water Use by Golf Courses in 2006

AMA	# of Golf Courses	# of Holes	# Acres	Water Demand (AF)	Water Supply
Phoenix	184	3,533	18,946	99,000	Groundwater (45%)
					Surface water (18%)
					CAP (14%)
					Effluent (23%)
Pinal	12	180	N/A	49,000 ¹	Groundwater (56%)
					CAP (35%)
					Effluent (9%) ¹
Prescott	6	108	N/A	3,000	Groundwater (30%)
					Effluent (70%)
Santa Cruz	4	72	535	2,000	Groundwater (97%) ²
					Remediated water (3%)
Tucson	43	838	4,312	21,000	Groundwater (47%)
					Surface water (2%)
					CAP (3%)
					Effluent (48%)

Note: Golf course water demand includes both industrial courses and those served by municipal providers.

¹ The volume of water associated with the Dave White Golf Course is not included within this number. This course receives effluent water directly from the City of Casa Grande's treatment plant and does not report usage to the AMA.

² Within the Santa Cruz AMA, water is not separately defined as surface water or groundwater so all volumes are reported under groundwater.

The largest water provider in the Phoenix AMA is the City of Phoenix which delivered 329,711 acre-feet of water in 2003. Its service area covers more than 500 square miles and serves a population in excess of 1.3 million (2000 Census). The City of Phoenix water system also provides water to a portion of the Town of Paradise Valley. The water system for the City includes four primary sources of supply with their associated percentages of use: surface water from the Salt and Verde river systems provided to the City by the SRP (54%); CAP water (36%); groundwater (3%); and effluent (7%) from three treatment facilities. The total potable system capacity is currently more than 780,000 acre-feet with a planned expansion to 1.2 maf. Major system components include five surface water treatment plants (Verde River plant, 24th Street, Deer Valley, Valley Vista and Union Hills); the Granite Reef Diversion Dam interconnect facility; a groundwater well system that includes 30 active wells; and more than 6,000 miles of water mains (City of Phoenix, 2005).

The City utilizes reclaimed water from the Cave Creek Water Reclamation Plant to irrigate turf in northeast Phoenix and provides reclaimed water from the 91st Avenue WWTP, through the Tres Rios Wetlands Project, to the Buckeye Irrigation Company and the Palo Verde Nuclear Generating Station for cooling purposes. The City also provides reclaimed water from the 23rd Avenue WWTP to the Roosevelt Irrigation District for agricultural irrigation. The volume of reclaimed water available exceeds demand and the City is developing ways to fully utilize this water source. (City of Phoenix, 2005)

The Cities of Mesa, Scottsdale, Tempe and Chandler, all located in the East Salt River Valley, each served over 50,000 acre-feet of water in 2003 (see Table 8.0-11). The City of Mesa is the second largest provider in the AMA; serving over 100,000 acre-feet of water in 2003. The western part of the Mesa service area is within the SRP and RWCD boundaries and receives Salt and Verde river water. Approximately half of Mesa's demand is supplied by the SRP and 11% by RWCD. Mesa utilizes a variety of other water supplies including groundwater, CAP water, other Colorado River water, SRPMIC lease water and effluent (City of Mesa, 2004). The City of Scottsdale delivered almost 78,000 acre-feet of water in 2003. About 48% of the City's demand is met with CAP water and 47% by groundwater. Less than 5% of its water supply is SRP surface water. Scottsdale operates the Scottsdale Water Campus that treats wastewater and CAP water. Wastewater is treated to irrigation standards for use at golf courses, and when irrigation needs are reduced in the winter, the wastewater is treated to drinking water standards and recharged to the aquifer via injection wells. (City of Scottsdale, 2007 and ADEQ, 2008) The City of Tempe delivered approximately 57,700 acre-feet of water to customers in 2003. Most of its water supply is surface water from the SRP. Groundwater provides from 1% to 7% of the total supply depending on surface water availability. In 2005, about 7% of Tempe's water demand was met by groundwater. (City of Tempe, 2006) The City of Chandler is the fifth largest water provider in the Phoenix AMA; delivering over 57,000 acre-feet of water in 2003. Water supplies include SRP water, Salt and Verde river water, CAP water, Colorado River water, groundwater and effluent (City of Chandler, 2002).

Pinal AMA

For the 2001-2003 time period, the average annual municipal demand in the Pinal AMA, excluding Indian demand, was 26,800 acre-feet. Average annual municipal demand has increased almost 20% over the last decade, spurred by a population that grew by 65% from 2000-2006. However, municipal demand is still a relatively small percentage of non-Indian demand within the AMA, accounting for only 3% of the demand. There are four population centers within the Pinal AMA, Casa Grande, Coolidge, Eloy, and Florence, with the fastest population growth occurring in the Casa Grande area where more than 70% of the municipal demand is located. Almost 85% of the municipal demand is met with groundwater, although the four water providers serving these population centers hold CAP allocations sufficient to meet almost 50% of the 2006 municipal demand. The lack of water treatment facilities to treat CAP water for potable use is currently a limiting factor to utilize this supply (City of Casa Grande, 2001).

The largest water provider in the Pinal AMA is a private water company, Arizona Water Company - Casa Grande System (AWCCG), that supplied 13,540 acre-feet of water to Casa Grande and the surrounding area in 2003. The service area for the AWCCG is about 140 square miles with a distribution system consisting of approximately 466 miles of pipes. The primary source of supply used by the AWCCG is groundwater withdrawn from 15 active wells. The AWCCG also provides

untreated CAP water to two private golf courses and an electric power plant within its service area. In addition, the City of Casa Grande WWTP delivers effluent to the power plant and the City's municipal golf course. The treatment plant produces approximately 2,900 acre-feet of effluent per year.

Prescott AMA

For the 2001-2003 time period, the average annual municipal demand in the Prescott AMA was 17,300 acre-feet. This includes Indian demand as the Yavapai-Prescott Indian Tribe currently receives potable water from the City of Prescott. The Prescott AMA continues to experience an increase in municipal water use and a decrease in agricultural demand. Municipal demand accounts for almost 70% of water use within the AMA and that demand is met primarily with groundwater. The "tri-cities" of Prescott, Prescott Valley and Chino Valley are the population centers of the Prescott AMA, with Prescott and Prescott Valley accounting for nearly 80% of the municipal deliveries.

The largest water provider in the Prescott AMA is the City of Prescott, which supplied over 6,900 acre-feet of groundwater in 2003 to a service area that covers approximately 50 square miles. Although groundwater is the primary source of water used to meet municipal demand, the City also holds surface water rights, including recently purchased rights to surface water stored in Watson and Willow Lakes. Due to the lack of a surface water treatment facility, any use of surface water is done through underground recharge and recovery. During the 2001-2003 time period the City of Prescott recovered 570 acre-feet of surface water recharge credits, delivered approximately 1,400 acre feet of effluent to turf facilities and recovered approximately 130 acre-feet of effluent recharge credits for municipal use.

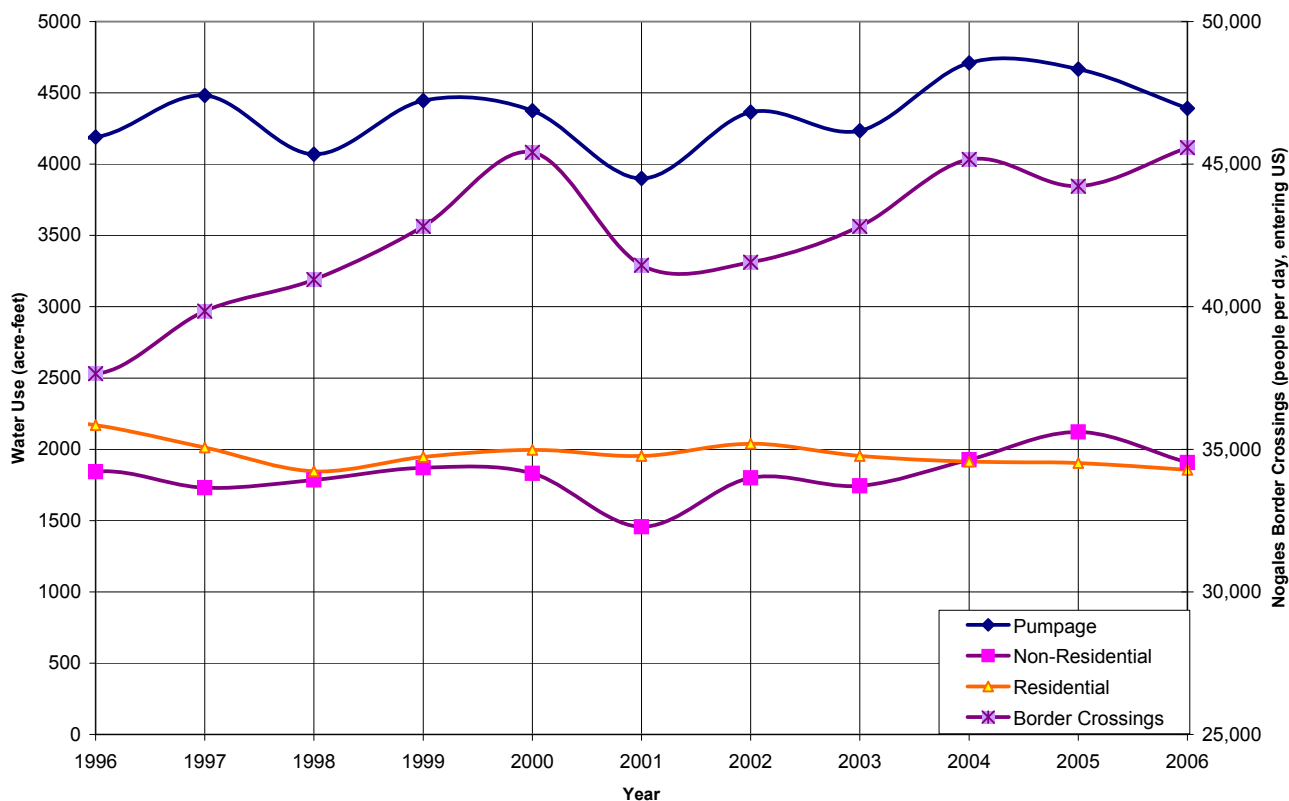
The second largest water provider in the Prescott AMA is the Town of Prescott Valley that supplied almost 5,000 acre-feet of groundwater in 2003. In 2003, the Town also recharged more than 1,700 acre-feet of effluent and directly delivered over 300 acre-feet of effluent for golf course use. The Town of Chino Valley and the newly incorporated town of Dewey-Humboldt meet most of their municipal demand through small private domestic (exempt) wells.

Santa Cruz AMA

For the 2001-2003 time period, the average annual municipal demand in the Santa Cruz AMA was 8,300 acre feet. There is no Indian demand within this AMA. Like the other AMAs, the Santa Cruz AMA is experiencing an increase in municipal demand; however, this is still secondary to agricultural demand. Municipal demand accounted for almost 35% of the total demand with the two primary demand centers served by the City of Nogales and Rio Rico Utilities. The service areas of these two providers have shown a 5-8% annual increase in population over the last decade.

The City of Nogales is the largest water provider and served more than 4,200 acre-feet to its customers in 2003. Its service area is located along the international border both east and west of Interstate 19, encompasses approximately 20 square miles, and includes areas both inside and outside the city limits. The City currently has a Designation of AWS, with an aggregate volume of 6,322 acre-feet per year in normal years, and 5,473 acre-feet per year in a drought year. Total pumpage by the City has fluctuated, with a slight increase during the period 1996-2006 (Figure 8.0-17). Fluctuations may be related to a number of factors including: the number of border

Figure 8.0-17 City of Nogales, Arizona water use 1996-2006



crossings, weather conditions, distribution system problems, and record-keeping changes. The City currently operates 14 wells, and relies on a combination of surface water and groundwater withdrawn from wells near the Santa Cruz River, as well as water withdrawn from the Potrero groundwater basin. One well near Coronado Canyon in the Potrero basin accounts for over one-third of the City's total pumpage.

Municipal water uses consist of residential demand, produce storage and processing, tourist service industry use, and light manufacturing. Two turf-related facilities, Palo Duro and Kino Springs golf courses, use water supplied by the City of Nogales. Residential demand has slightly decreased, while non-residential demand has increased since 1996. Nogales has a relatively high GPCD rate due in part to the greater proportion of non-residential water demand (approximately 1:1 with residential use). Part of this non-residential demand is due to water uses associated with the large number of people who cross the border from Nogales, Sonora into Nogales, Arizona each day. Annual non-residential demand trends closely track the number of border crossings reported by US Customs and Border Patrol; in particular, a reduction in crossings due to increased border security measures implemented in 2001 corresponds to a steep drop in demand. Overall, the number of border crossings into Arizona at the Nogales ports of entry rose 21% from 1996-2006 (see Figure 8.0-17).

Tucson AMA

For the 2001-2003 time period, the total annual municipal demand in the Tucson AMA was 181,980 acre-feet, excluding Indian demand. Municipal demand accounts for almost 56% of the total non-Indian demand and almost 78% of that demand was met with groundwater supplies during 2001-2003. In general, surface water sources are limited within the Tucson AMA and

CAP water is the most abundant renewable supply available. The City of Tucson, one of the four population centers of the AMA, accounts for approximately 68% of the municipal demand. The other population centers are Marana, Oro Valley and the Sahuarita/Green Valley area.

The City of Tucson municipal water utility, Tucson Water, has the highest municipal demand of any large water provider in the Tucson AMA. In 2003 it served over 123,000 acre-feet of water to its customers within a service area approximately 300 square miles in size. The City's system includes both a potable and non-potable (reclaimed) system. (City of Tucson, 2004)

Until the 1990s, Tucson Water relied solely on groundwater and a relatively small volume of effluent for its supply, although it currently has a CAP allotment of 144,000 acre-feet. In 1992, Tucson Water began direct delivery of CAP water to residential customers. Those deliveries were discontinued in 1994 due to aesthetic issues and delivery problems. In 1995, a voter approved initiative restricted Tucson Water from delivering treated CAP water directly. In response to this initiative, Tucson Water chose to recharge the CAP water and then deliver the recovered water to residential customers. In 1996, Tucson Water began operation of the 80,000 acre-foot Central Avra Valley Storage and Recovery Project (CAVSRP). In 2008, a second recharge facility, the 60,000 acre-foot Southern Avra Valley Storage and Recovery Project (SAVSRP), was completed (see Figure 8.5-9). A series of recovery wells has been constructed in conjunction with each of these recharge sites with the anticipation that Tucson Water will eventually be able to store and recover its entire CAP allocation.

Tucson Water also relies on effluent to meet demand and offset the use of groundwater. In 2000, reclaimed water use accounted for 8% of Tucson Water's total demand. (City of Tucson Water Department, 2004) Average annual effluent demand was approximately 11,600 acre-feet during the 2001-2003 time period. Golf courses in the City of Tucson and Oro Valley consume approximately 66% of the reclaimed water. The rest is served to parks, schools and individual home owners. In addition to direct delivery of reclaimed water deliveries through the non-potable system, the City of Tucson recharges a portion of its effluent. (City of Tucson Water Department, 2007)

In addition to Tucson Water, eleven water providers serve over 1,000 acre-feet of water annually in the Tucson AMA. In the northwest area of the Tucson AMA the largest providers are the Town of Oro Valley, which served approximately 10,233 acre-feet in 2003, and Metropolitan Domestic Water Improvement District (Metro Water), which served 9,002 acre-feet in the same year. Green Valley Water Company and the Community Water Company of Green Valley served a combined total of 5,022 acre-feet to their customers in 2003. A number of large providers in the Tucson AMA have a CAP allocation; however, many do not have physical access to the supply and currently none are serving it directly (see Appendix B). A growing number of providers are using their allocations through annual storage and recovery.

Agricultural Demand

The planning area includes AMAs where agriculture is the predominant demand sector and AMAs with little agricultural use, although agricultural demand exists in every AMA. Total annual average non-Indian agricultural demand for the 2001-2003 time period was in excess of 1.8 maf

(see Table 8.0-13). Agricultural demand is the greatest in the Phoenix and Pinal AMAs where it accounts for almost 42% and 95% respectively, of the total non-Indian demand.

Table 8.0-13 Agricultural demand in the AMA Planning Area excluding Indian demand

	1991-1995 (acre-feet)	1996-2000 (acre-feet)	2001-2003 (acre-feet)
<i>Phoenix AMA</i>			
Groundwater	453,800	431,700	388,100
Surface Water	453,100	262,000	168,900
CAP	119,000	292,200	266,100
Effluent	30,000	59,700	65,000
Other	2,000	2,000	2,100
Total	1,057,900	1,047,600	890,200
<i>Pinal AMA</i>			
Groundwater	297,600	397,100	383,800
Surface Water	162,600	99,900	52,100
CAP	269,600	373,800	409,700
Effluent	2,800	1,500	1,600
Total	732,600	872,300	847,200
<i>Prescott AMA</i>			
Groundwater	5,600	5,400	4,000
Surface Water	9,500	3,100	600
Effluent	900	1,400	1,500
Total	16,000	9,900	6,100
<i>Santa Cruz AMA</i>			
Groundwater	11,400	13,500	14,000
Total	11,400	13,500	14,000
<i>Tucson AMA</i>			
Groundwater	85,000	82,300	76,600
CAP	3,000	23,400	16,800
Effluent	2,600	1,400	0
Total	90,600	107,100	93,400
Total All Basins	1,908,500	2,050,400	1,850,900

Notes:

Within the Santa Cruz AMA water is not separately defined as surface water or groundwater, therefore all volumes are reported as groundwater.

Agricultural water use within AMAs is subject to Groundwater Code regulations that limit use of groundwater for irrigation purposes in several ways. Within AMAs there is a prohibition on new irrigated lands and management plan conservation requirements set maximum annual groundwater allotments. The maximum annual groundwater allotment for an irrigation right is determined by multiplying the irrigation water duty by the water duty acres in the farm. The irrigation water duty is the annual amount of water (in acre-feet per acre) that is reasonable to apply to land to produce the crops historically grown (1975 to 1980) divided by an assigned irrigation efficiency. To be in compliance with management plans, irrigation efficiency must improve through time. Under the management plans, agricultural water users may participate in alternative conservation programs such as the historic cropping program or a best management practices (BMP) program. All agricultural conservation programs are required to conserve equivalent volumes of water.

Due to the AMA regulations that restrict new irrigated acres and require improved efficiencies, agricultural demand should not significantly increase within the AMAs as may occur in non-AMA planning areas. Additionally, as the AMA population centers grow, urbanization should result in a decrease in agricultural demand over time. This is evident in the Phoenix AMA where over 130,000 acres of agricultural land have been urbanized since 1984.

The AMA Planning Area includes two of the largest agricultural areas in Arizona, Pinal and Maricopa Counties, located in the Pinal and Phoenix AMAs, respectively. Only Yuma County is larger statewide in terms of production and water use. Crops grown in Maricopa County include (in order of harvested acres for 2003) alfalfa hay, upland cotton, wheat, principal vegetables (includes lettuce, broccoli, cauliflower, onion, and melons), barley, citrus, other hay and corn for grain. Annual agricultural sales are reported to total over \$740 million. In Pinal County, the crops grown include (in order of harvested acres for 2003) upland cotton, alfalfa hay, durum wheat, barley, corn for grain, other hay, and Pima cotton. Annual agricultural sales are reported to total over \$424 million (NASS, 2008).

There are 39 irrigation districts within the planning area located as follows: Phoenix AMA (33); Pinal AMA (4); Prescott AMA (1); Santa Cruz AMA (0); and Tucson AMA (1). Figure 8.0-18 shows the general location of the largest irrigation districts within the planning area.

Figure 8.0-18 Large irrigation districts in the AMA Planning Area

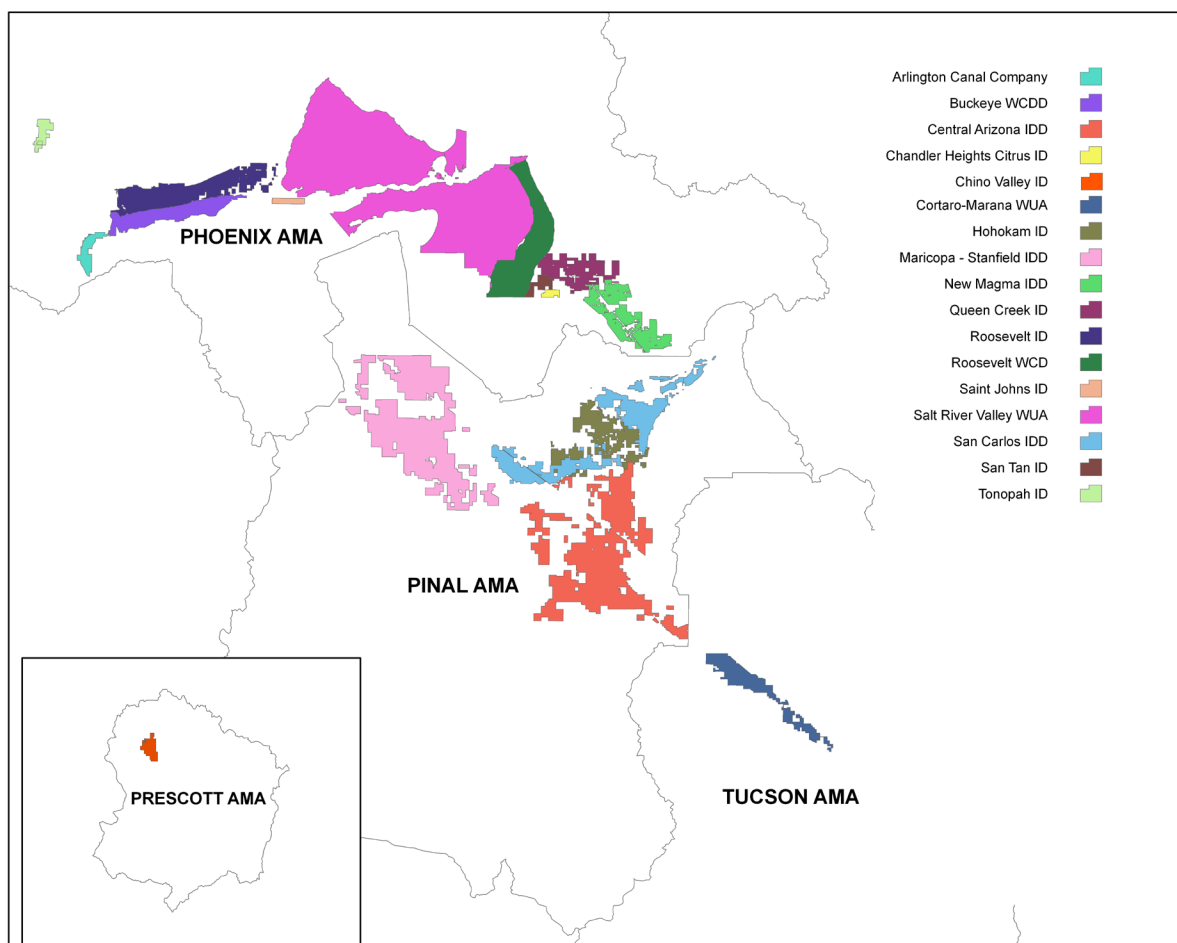
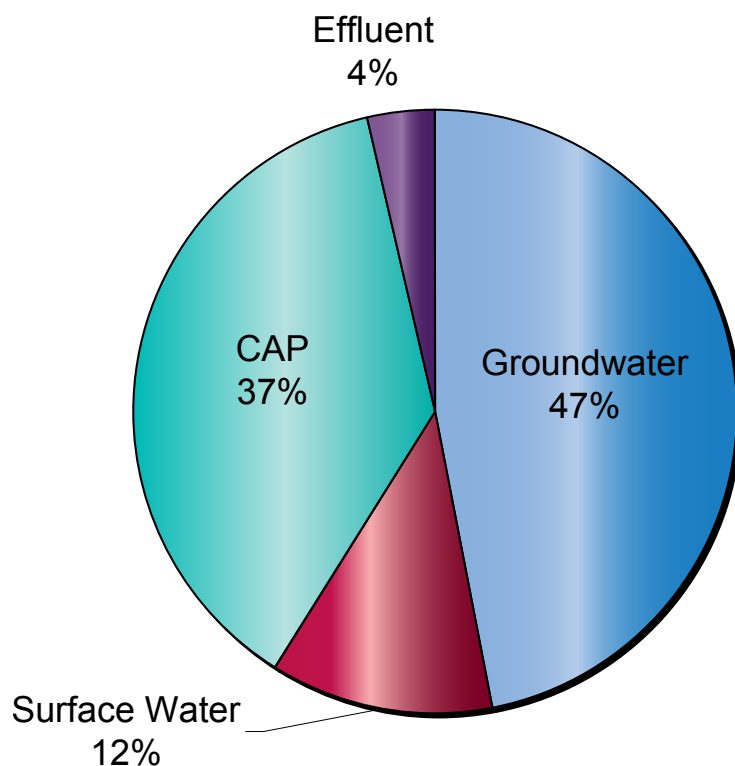


Figure 8.0-19 Average agricultural water use in the AMA Planning Area 2001-2003



The source of water used for irrigation differs widely throughout the planning area. Due to regulations on agricultural water users within the AMAs, some irrigation districts utilize a number of different water sources to ensure that they remain in compliance with conservation requirements. Overall, the sources of water available are groundwater, in lieu water, CAP water, effluent, surface water, and tailwater. In lieu water is a renewable water supply, typically CAP water, that is delivered by a water storer to a groundwater savings facility (GSF), typically a farm or irrigation district, pursuant to permits issued under A.R.S. § 45-812.01. The in lieu water is used in an AMA or an irrigation non-expansion area (INA) by the recipient (agricultural water user) on a gallon-for-gallon substitute basis for groundwater that otherwise would have been pumped from within that AMA or INA. In lieu water is included as CAP water demand in the Atlas. Water supplies used by the agricultural sector are shown in Figure

8.0-19. Approximately 47% of the agricultural demand is met by groundwater, 37% by CAP water, 12% by surface water and 4% by effluent.

Water that runs off the end of the field after an irrigation event is called tailwater and is used most frequently in the Phoenix AMA. Irrigators benefit by capturing and reusing this runoff because while the first application of water is counted within the allotment given to agricultural rightholders, if tailwater can be collected and re-used in any way, the second (and subsequent) applications of water do not count against an allotment. Use of tailwater is a component of the Agricultural BMP conservation program previously discussed.

Phoenix AMA

Average non-Indian agricultural demand in the Phoenix AMA for the 2001-2003 time period was just over 890,000 acre-feet per year, or 40% of the total agricultural demand in the planning area. Agricultural water demand has shown a decreasing trend over the last decade. The majority (approximately 80%) of agricultural demand is associated with seven of the largest irrigation districts: Salt River Project, Roosevelt Irrigation District (RID), Roosevelt Water Conservation District (RWCD), Buckeye Water Conservation and Drainage District (Buckeye), New Magma Irrigation and Drainage District (NMIDD), Maricopa Water District and Queen Creek Irrigation District. Most of the irrigated lands are located in the central and south-central portions of the AMA (see Figure 8.1-12). Water supplies to meet agricultural demand include groundwater, in lieu water, CAP water, surface water, effluent and tailwater. All seven of the largest irrigation districts utilize at least three different sources of supply. The largest irrigation district within the Phoenix AMA is the SRP.

Analysis of agricultural water demand trends of five irrigation districts in the Phoenix AMA shows an overall decrease in water use of approximately 11,500 acre-feet per year between 1984 and 2002. There have been spatial variations in this decrease due to the proximity of agricultural lands to urban areas and the availability and cost of water supplies. Agricultural lands in the SRP service area decreased by more than 50% from 1984 to 2002 with an associated reduction in demand of approximately 9,800 acre-feet/year. RWCD, also located near the Phoenix metropolitan area, experienced similar declines, though not as pronounced as SRP. Demand within the RID, located on the western edge of the Phoenix metropolitan area, has been stable, likely due to increased utilization of effluent and changes in crop type. Buckeye, located south of and adjacent to RID is in a waterlogged area, requiring pumping of excess water. Water demand has increased within RID, likely due to increased farming to offset reductions in production in other parts of the AMA. Similarly, demand increased within the NMIDD, located in the southeastern part of the AMA. The increase is likely related to the availability of Colorado River water and, like RID, increased farming to offset reductions in production due to urbanization. (Hetrick and Roberts, 2004)

Pinal AMA

Non-Indian agricultural demand in the Pinal AMA for the 2001-2003 time period averaged approximately 847,000 acre-feet per year, or 46% of the total agricultural demand in the planning area. Agricultural water demand has remained relatively constant in the Pinal AMA with a 15-year average water use of approximately 778,000 acre-feet per year. However, there has been a significant shift in the source of supply within the Pinal AMA (see Table 8.2-10). Prior to the availability of CAP water in the AMA (approximately 1987) almost all agricultural demand was met with groundwater or surface water supplies from the Gila River. Today, approximately 410,000 acre-feet of CAP water is used to meet demand.

The majority (approximately 87%) of agricultural demand in the AMA is associated with four large irrigation districts: Central Arizona Irrigation and Drainage District (CAIDD), Maricopa-Stanfield Irrigation and Drainage District (MSIDD), Hohokam Irrigation and Drainage District (HIDD), and San Carlos Irrigation and Drainage District (SCIDD). Most irrigated lands are located in the northern half of the AMA (see Figure 8.2-12). Groundwater is pumped to supplement CAP deliveries in CAIDD, MSIDD and HIDD and surface water in SCIDD, up to the total amount of water allotted annually to the farms in each district. SCIDD receives and distributes surface water from the Gila River pursuant to the Globe-Equity Decree⁶.

The largest irrigation district within the Pinal AMA is MSIDD. The MSIDD was organized in 1962 to obtain supplemental water from the CAP and construction of all CAP facilities in the district was completed in 1989. The district operates the Santa Rosa Canal, 78 miles of main conveyance canals, 116 miles of lateral canals and pipelines and 484 irrigation wells. MSIDD does not own the individual irrigation wells but leases them from the landowners; only 80 are directly connected to MSIDD's distribution system. The district boundaries encompass approximately 148,000 acres and 89,000 acres have a recent history of irrigation.

⁶ In 1935 the U.S. District Court entered a consent decree (Globe Equity No. 59) for all diversions of the mainstem of the Gila River from its confluence with the Salt River to the headwaters in New Mexico, including the Gila River and San Carlos Apache reservation and non-Indian landowners below and above Coolidge Dam.

Prescott AMA

Average annual agricultural demand in the Prescott AMA for the 2001-2003 time period was 6,100 acre-feet, or less than 1% of the total agricultural demand in the planning area. There has been a significant decrease (approximately 60%) in agricultural use within the AMA over the past two decades. Agricultural demand is now approximately 24% of the total Prescott AMA demand. Historically, both groundwater and surface water supplies were utilized to meet agricultural demand; however, there has been a shift to greater utilization of groundwater and recovery of effluent credits due to transfer of Chino Valley Irrigation District (CVID) surface water rights to the City of Prescott.

Most of the irrigated lands are located in the northern part of the AMA near the Town of Chino Valley (approximately 1,800 acres) where groundwater and recovered effluent are used. An additional 476 acres are currently irrigated with groundwater in the southern portion of the AMA along the Agua Fria River (see Figure 8.3-12).

The only irrigation district within the Prescott AMA is CVID, located in the Little Chino Sub-basin. CVID originated at around the turn of the 20th century as the Arizona Land and Irrigation Company and was incorporated as CVID in 1926. Historically, the CVID was entirely a surface water provider that supplied water to slightly more than 2,500 acres of irrigated lands (Gookin, 1977). Surface water was diverted from two reservoirs, Watson Lake and Willow Lake that are connected by a cross-cut canal constructed in 1965. In 1998, CVID entered into an intergovernmental agreement (IGA) with the City of Prescott in which CVID's surface water rights were relinquished to the City. Pursuant to the IGA, all CVID deliveries from Prescott are now effluent through recovery of long-term storage credits; however, CVID retained a small commitment to serve surface water to three CVID properties (< 30 acre-feet). The maximum annual recovery limit under the IGA is 1,500 acre-feet until a total of 33,000 acre-feet have been recovered. As of 2007, CVID consisted of approximately 480 irrigated acres and had ceased delivery of surface water.

Santa Cruz AMA

Agricultural demand in the Santa Cruz AMA for the 2001-2003 time period averaged 14,000 acre-feet per year, or less than 1% of the total agricultural demand in the planning area. Agricultural demand has remained relatively stable in the AMA, which has no organized irrigation districts. The predominant agricultural use is pasture land and one irrigation right holder accounts for 33-50% of all agricultural use in the AMA.

Tucson AMA

Non-Indian agricultural demand in the Tucson AMA for the 2001-2003 time period averaged 93,400 acre-feet per year, or approximately 5% of the total agricultural demand in the AMA Planning Area. Agricultural demand has remained relatively constant and accounts for approximately 28% of the Tucson AMA water demand. Groundwater is the primary agricultural water supply. During 2001-2003, in lieu CAP water was also used, which met about 18% of the agricultural demand. There are two primary agricultural centers: Avra Valley near the town of Marana, and the Green Valley area along the Santa Cruz River (see Figure 8.5-12).

The only agricultural irrigation district in the AMA with a consolidated distribution system is the Cortaro-Marana Irrigation District (CMID). Located in the Avra Valley/Marana area, the District

is an arm of the Cortaro Water Users' Association, which was formed in 1948. CMID pumps water from wells to serve its customers. It has several surface water rights and claims wells as points of diversion; however, the Department accounts for this water as groundwater in its water budget. The District operates a delivery system that provides water to about 11,000 irrigated acres. The system consists of almost 54 miles of concrete lined canals, eight miles of pipeline and 45 irrigation wells. In 2003, CMID delivered approximately 40,000 acre-feet of water to its customers. Approximately 2,000 acre-feet of this water was in lieu CAP.

Other farming operations in the Avra Valley include those within the Avra Valley Irrigation District (which does not operate a consolidated distribution system), BKW Farms, and other irrigators. Both groundwater and CAP water are used to irrigate crops, which are predominantly cotton in this area. In 2003 approximately 16,000 acre-feet of groundwater was used, along with approximately 6,900 acre-feet of in lieu CAP.

A large agricultural operation, Farmers Investment Company (FICO), is located in the Sahuarita – Green Valley area and consists of predominantly pecans. FICO is separated into two operating areas: the northern section has approximately 4,000 acres and the southern section approximately 1,800 acres. FICO used approximately 28,400 acre-feet of groundwater in 2003. Although FICO is currently permitted to receive in lieu CAP, the physical infrastructure necessary to deliver CAP does not yet exist.

Another relatively large farming operation is located in the northern part of the AMA near Red Rock. Kai Farms-Red Rock grows predominantly row crops and has recently planted pecans. In lieu CAP water and groundwater are used for irrigation. In 2003, 8,378 acre-feet of in lieu CAP was used to meet demand.

Industrial Demand

Industrial demand in the AMA Planning Area averaged just over 283,000 acre-feet annually between 2001 and 2003, with 2003 demand slightly more than 250,000 acre-feet. Industrial demands accounted for 7.5% of the total water demand in the planning area during the 2001-2003 time period.

While the composition of industrial demand differs among the AMAs, turf demand is the highest demand sector overall, followed by power plants and mining. Industrial demand is the greatest in the Phoenix AMA with 75% of the total industrial demand in the planning area. The Tucson AMA has the second largest volume of industrial demand in the planning area, accounting for 18% of the total. (See Table 8.0-14)

Within the AMA Planning Area, industrial water use is specifically defined as water that is utilized pursuant to specific non-irrigation groundwater rights or permits. Water that is supplied by municipal providers for industrial or commercial use is not reflected within the industrial sector but is instead included within municipal demand. Based on this definition of industrial use, the predominant source of supply is groundwater; however, some CAP water and effluent is used to meet demands. All users classified as industrial users within the AMAs have general conservation requirements under the AMA management plans. Additional, specific conservation requirements exist for turf-

related facilities, power plants, sand and gravel facilities, dairies, feedlots, large cooling facilities, new large landscape users and new large industrial users. “Other industrial users” shown in Table 8.0-14 are subject to the general requirements that apply to all industrial users.

Table 8.0-14 Industrial demand in selected years in the AMA Planning Area

	1991	2000	2003
Type/AMA	Water Use (acre-feet)		
Power Plant Total	52,800	67,500	67,800
Phoenix AMA	51,500	62,600	64,200
Pinal AMA	0	0	700
Tucson AMA	1,300	4,900	2,900
Turf Total¹	70,500	106,000	101,100
Phoenix AMA	60,200	93,400	88,100
Pinal AMA	1,600	2,700	2,600
Prescott AMA	400	500	800
Santa Cruz AMA	1,100	1,100	1,100
Tucson AMA	7,200	8,300	8,500
Dairy/Feedlot Total	10,270	15,300	19,500
Phoenix AMA	7,400	10,500	12,400
Pinal AMA	2,800	4,700	7,000
Tucson AMA	70	100	100
Mining Total²	53,350	51,300	42,090
Phoenix AMA	7,600	6,700	9,100
Pinal AMA	400	300	1,400
Prescott AMA	50	100	70
Santa Cruz AMA	200	100	120
Tucson AMA	45,100	44,100	31,400
Other Total³	16,470	21,800	27,800
Phoenix AMA	11,700	15,000	20,000
Pinal AMA	800	2,000	3,200
Prescott AMA	70	400	700
Santa Cruz AMA	200	200	200
Tucson AMA	3,700	4,200	3,700

Source: ADWR 2008

¹ Turf-related facilities include golf courses, schools, parks, cemeteries and common areas of subdivisions

² Mining uses include both hard rock or metal mining and sand and gravel operations

³ Other category includes water used by large cooling users, new large landscape users, new large industrial users and other users

Phoenix AMA

Industrial demand in the Phoenix AMA in 2003 was 193,800 acre-feet or 75% of the total industrial demand in the planning area. On average, industrial demand was approximately 213,600 acre-feet/yr during 2001-2003, or 10% of the Phoenix AMA non-Indian demand. The largest industrial use category in the AMA is turf related facilities, primarily golf courses, which accounted for 45% of the industrial use in 2003. Power plants, specifically the Palo Verde Nuclear Generating Facility,

are the second highest use at 35%. Palo Verde uses over 60,000 acre-feet per year, a majority of which is effluent. Although the total annual demand in the AMA has been increasing, the portion attributed to industrial use has remained fairly stable.

Though dairy operations have been relocating from the Phoenix AMA to the Pinal AMA and rural Arizona, there are still 87 large-scale operations in the AMA representing 6% of the total industrial demand in 2003. Sand and gravel operations are a fairly stable demand within the Phoenix AMA with approximately 5% of the total industrial demand. Approximately 10% of the industrial demand is by “other” industrial users such as small-scale dairies, industrial facilities and high water use landscape areas less than ten acres in size.

Pinal AMA

Industrial demand in the Pinal AMA in 2003 was 14,900 acre-feet, or 6% of the total industrial demand in the planning area. On average, industrial demand was 14,000 acre-feet/yr during 2001-2003, or 2% of the Pinal AMA non-Indian demand. The largest industrial use category in the AMA is dairies and feedlots. Seventeen new, large-scale dairies were constructed in the Pinal AMA during the period from 2000 to 2006, bringing the total number to 28. Many of the new dairies relocated from the Phoenix AMA, as that area underwent urbanization. The number of new dairies in the AMA has leveled off, with only three dairies having started operation since January 2004. The Department is aware of only one dairy that is currently in the planning stage and likely to be constructed. In addition to the increased industrial demand associated with new dairies, the increase in the number and size of dairies has led to both a significant increase in the acreage of forage crops and conversion to forage crops in the AMA, impacting agricultural demand as well.

Prescott AMA

Industrial demand within the Prescott AMA is limited to two golf courses (Prescott Country Club and Quailwood), sand and gravel operations and other industrial uses. Groundwater is the only water supply used by the industrial sector. The 2003 demand was approximately 1,570 acre-feet, less than 1% of the total industrial demand in the planning area. On average, industrial demand was approximately 1,500 acre-feet/yr, or 6% of the Prescott AMA demand during 2001-2003.

Santa Cruz AMA

Approximately 6% of the average (2001-2003) total water demand in the Santa Cruz AMA is industrial. In 2003, industrial demand was 1,420 acre-feet, less than 1% of the total industrial demand in the planning area. Most industrial demand occurs at two industrial golf courses, other turf-related facilities, and sand and gravel operations.

Tucson AMA

Industrial demand in the Tucson AMA in 2003 was 46,600 acre-feet, or 18% of the total industrial demand in the planning area. On average, industrial demand was approximately 51,300 acre-feet during 2001-2003, accounting for 16% of the Tucson AMA demand. Industrial demand is met primarily with groundwater.

The mining sector accounts for almost 70% of the industrial demand in the AMA. The majority of mining demand is from the metal mining industry, specifically copper. Water use in this industry

has fluctuated through time, reaching a peak in the mid 1990s when almost 50,000 acre-feet of water was used. By 2002, water use fell by almost half due to low copper prices. More recently, with the price of copper at historic highs, mining water use numbers are on the rise. Historically, all mining water use has been supplied by groundwater.

In addition to the metal mining industry, other industrial users in the Tucson AMA include sand and gravel facilities, turf facilities, electric power plants, a dairy and other types of industrial users.

8.0.8 Water Resource Issues in the AMA Planning Area

A number of complex issues exist in the AMA Planning Area. Issues have been identified by the Department within management plans, through stakeholder processes, a Governor's Commission, the Arizona Town Hall, and numerous community water resource groups. Groundwater pumping, achievement of management goals, access to renewable water supplies, statutory constraints, environmental protection, local area management and increasing salinity are some of the important considerations in the planning area. Discussed below are issues that have been identified in the past decade and are common to multiple AMAs. The Department is currently identifying AMA issues as it begins development of the fourth management plan and will more specifically evaluate them through that process.

Residual (Allowable) Groundwater Pumping and Management Goals

The amount of groundwater withdrawals allowed under the Groundwater Code, management plans and Assured Water Supply (AWS) Rules through groundwater rights, groundwater permits, and certificates and designations of AWS creates a significant obstacle towards achieving AMA management goals. Four of the five AMAs have a safe-yield component as part of their goal. Safe-yield is defined as, "to achieve and thereafter maintain a long-term balance between the annual amount of groundwater withdrawn in an active management area and the annual amount of natural and artificial groundwater in an active management area." A.R.S. § 45-561(12). Groundwater pumped in excess of safe-yield is termed groundwater "mining" or overdraft.

The safe-yield AMAs (Phoenix, Prescott, Santa Cruz and Tucson) have made progress toward achieving their management goals through recharge, replenishment, retirement of agricultural pumpage and conservation although there are still challenges. As allowed by the Code, AWS Rules and the management plans, the responsibility to reduce mined groundwater pumping does not apply proportionately or equitably to all water-using sectors. For example, water providers designated as having an AWS are required to use renewable supplies, though they are authorized to continue to use a limited amount of groundwater. Although there are incentives in the management plans for industrial and agricultural users to use renewable water supplies, there are no mandatory restrictions. Access to sufficient non-groundwater sources by these water users is also a long-term obstacle to achieving safe-yield. In some AMAs the allowable pumping volume may be a large proportion of the overdraft.

Pumpage by domestic/exempt wells is a water use that is neither subject to groundwater replenishment or management plan requirements. Exempt well pumpage represents a significant amount of water demand in some AMAs. For example, it is estimated that there are over 9,000 exempt wells in use in the Prescott AMA, which may account for as much as 25 percent of the

municipal water use. (Since exempt wells are exempt from the Department’s reporting requirement, the actual water use is unknown). With the ongoing practice of parcel splits not subject to the State’s subdivision laws, the number of exempt wells serving these parcels is expected to increase. Dry lot developments, where each lot owner drills their own well due to the lack of a centralized water service, may also increase.

Access to Renewable Water Supplies

Utilization of renewable supplies has increased over the past 20 years, facilitated by the construction of surface water treatment plants and completion of the CAP, allowing use of Colorado River water either directly or indirectly through artificial recharge and recovery projects. A number of issues have been identified associated with the use of CAP water. These issues include: limited CAP supplies; the need to construct new infrastructure to permit full utilization of supplies; financing of infrastructure; and the long term roles of the Central Arizona Groundwater Replenishment District (CAGRD) and the Arizona Water Banking Authority (AWBA) to ensure long-term availability of renewable supplies for AMAs.

As groundwater supplies diminish and more development occurs that requires groundwater replenishment (e.g. the AWS Rules), there will be more competition for renewable water supplies to meet current and future demands. In addition to the current users, smaller water providers and other groundwater users may not have physical access to these supplies to offset their ongoing use of groundwater. The reallocation of CAP Non-Indian Agricultural water is an example of how much interest there is in renewable water supply acquisition, even for a relatively small volume of low priority, expensive water.

A number of CAP Municipal and Industrial (M&I) subcontractors lack direct access to CAP water and must utilize the resource indirectly through underground storage facilities (USF), or groundwater savings facilities (GSF), located in proximity to the CAP infrastructure. Because the recovery is not required to occur in the area of replenishment, some areas may experience local water level declines and encounter physical availability limitations in the future. Funding for extension of the CAP canal in Tucson, as well as for treatment and other secondary infrastructure in all AMAs, is an issue to renewable supply utilization in some areas.

The CAGRD is also competing for the same renewable water supplies as other users in the Phoenix, Tucson and Pinal AMAs in order to meet its replenishment obligations to its member lands and member service areas under the AWS program. Developers and water providers contract with the CAGRD to replenish groundwater withdrawals as required by the AWS Rules. If the CAGRD cannot meet its obligations, its plan of operation will be considered inconsistent with the AMA management goal, which could impact approval of AWS Certificates and jeopardize the status of AWS Designations. There are also concerns regarding the spatial disconnect between CAGRD storage sites and recovery sites.

AMAs without access to CAP water must look to other water supplies to meet their management goals. For the Prescott AMA transporting alternative long-term supplies into the AMA is critical to achieving safe-yield in this groundwater-dependent AMA. The only alternative supplies currently available are a limited amount of effluent and transportation of groundwater from the adjacent Big Chino Sub-basin pursuant to A.R.S. § 45-555. In the Santa Cruz AMA access to both renewable

and groundwater supplies are influenced by water demand in the large upstream community of Nogales, Sonora. Some of this demand is offset by delivery and treatment of effluent generated in Mexico at the Nogales, Arizona, International Wastewater Treatment Plant (IWWTP), which discharges treated effluent to the Santa Cruz River near Rio Rico. However, there are currently no treaties or legal agreements regarding rights to the treated effluent nor for continued delivery and treatment of Mexican effluent at the IWWTP.

Effluent is a growing renewable resource in all AMAs, but physical distance between the location where the effluent is generated and the location of potential users, and lack of delivery infrastructure, limit its direct use in some areas. As with CAP water, recharge and recovery is utilized with similar concerns about the spatial disconnect between storage and pumping.

Statutory differences between groundwater and non-groundwater sources and conjunctive use
Groundwater and surface water are managed under different statutes with limited integration and consistency in approach. In the rapidly growing AMAs with multiple water sources, the statutory ability to manage only groundwater may be problematic. If any groundwater is part of the supply, the entire supply can be managed as groundwater, but there are many instances where non-groundwater supplies are exclusively used. Water management efforts are currently fragmented because effluent, CAP water, surface water and groundwater are all regulated differently and owned and controlled by different entities. This fragmentation exacerbates other issues, particularly those associated with ownership of water supplies. An exception is the Santa Cruz AMA, where the legislation that created the AMA expressly addressed its unique hydrogeology and the inter-connection of surface and groundwater supplies. It is necessary to coordinate management of these supplies to meet the Santa Cruz AMA management goal due to the highly seasonal and drought-sensitive conditions along the Santa Cruz River.

Environmental Protection

Few perennial riparian habitats remain in the AMA Planning Area; restoration and preservation of these areas have become a high priority in some AMAs. Issues center on the effects on these areas by continued groundwater pumping and surface water diversions. These riparian areas function as natural recharge zones through streambed infiltration and can beneficially serve both environmental and water management objectives if managed appropriately.

Critical Area Management

There is a growing consensus throughout the AMA Planning Area that a mechanism is needed to address water management problems in specific geographic areas within each AMA. Currently, management goals and programs apply to the entire AMA, regardless of local conditions. However, within AMAs areas exist with specific critical concerns. For example, hydrologic conditions can vary widely, from waterlogged areas to areas with severe groundwater overdraft that may result in land subsidence, earth fissures, and aquifer compaction. Areas of severe overdraft may compromise water supply reliability for local groundwater dependent users who may not have access to renewable water supplies.

Salinity

Salinity, or total dissolved solids (TDS) levels in CAP water, surface water and effluent typically

exceed that in native groundwater. As these supplies are increasingly utilized in the planning area, salinity levels will increase in both soil and groundwater. Human activities also contribute salts through industrial and commercial waste, water softeners and other wastes. It is estimated that 1.3 million tons of waterborne salts are annually transported into the Phoenix area from the Salt River and CAP canal and another 140,000 tons of salt are added annually from human activity. Studies suggest there is an annual net gain of approximately 1.1 million tons of salts in the Phoenix area and about 100,000 tons in the Tucson area. (USBOR, 2003)

High salinity levels in water reduce its suitability for some uses or may require more extensive and expensive treatment. Salinity reduces the life of household appliances, may require water softening for some purposes, and reduces crop yields. Salt accumulation in agricultural area soils requires supplemental water to flush salts below plant root zones. Because salts become concentrated in wastewater, irrigation with reclaimed water may be problematic and its disposal increases salt-loading in groundwater. Typical TDS levels in Phoenix area reclaimed water range from 800 to 1400 mg/l compared to a range of 580 to 650 mg/l found in CAP water. Although not currently perceived as a critical issue, it is a growing concern that is being actively studied. (USBOR, 2003)

8.0.9 AMA Water Resource Characteristics

Sections 8.1 through 8.5 present data and maps on water resource characteristics of the groundwater basins in the AMA Planning Area. A description of the data sources and methods used to derive this information is found in Section 1.3 of Volume 1 of the Atlas. This section briefly describes general information that applies to all of the basins and the purpose of the information. This information is organized in the order in which the characteristics are discussed in Sections 8.1 through 8.5.

Geographic Features

Geographic features maps are included to present a general orientation to principal land features, roads, counties and cities, towns and places in the groundwater basin.

Land Ownership

The distribution and type of land ownership in a basin have implications for land and water use. Large amounts of private land typically translate into opportunities for land development and associated water demand, whereas Federal lands are typically maintained for a public purpose with relatively little associated water use. State-owned land may be sold or traded, and is often leased for grazing and farming. The extent of State-owned lands is due to a number of legislative actions. The State Enabling Act of 1910 and the Act that established the Territory of Arizona in 1863 set aside sections 2, 16, 32 and 36 in each township to be held in trust by the State for educational purposes. Other legislation authorized additional State Trust Lands for specified purposes, which are identified for each basin (ASLD, 2006).

Climate

Climate data including temperature, rainfall, evaporation rates and snowfall are critical components of water resource planning and management. Averages and variability, seasonality of precipitation and long term climate trends are all important factors in demand and supply planning. Important in

the AMA Planning Area is the heat island effect, which is affecting climate in the major metropolitan areas.

Surface Water Conditions

Depending on physical and legal availability, surface water may be a potential supply in a basin. Stream gage, flood gage, reservoir, stockpond and runoff contour data provide information on physical availability of this supply. Seasonal flow information is relevant to seasonal supply availability. Annual flow volumes provide an indication of potential volumetric availability.

Criteria for including stream gage stations in the AMA tables are that there is at least one year of record, and annual streamflow statistics are included only if there are at least three years of record. There are different types of stations and those that only serve repeater functions were not included.

Flood gage information is presented to direct the reader to sources of additional precipitation and flow information that can be used in water resource planning. Large reservoir storage information provides data on the amount of water stored in the basin, its uses, and ownership. Because of the large number of small reservoirs, and less reliable data, individual small reservoir data is not provided. The number of stockponds is a general indicator of small-scale surface water capture and livestock demand. Runoff contours reflect the average annual runoff in tributary streams. They provide a generalized indication of the amount of runoff that can be expected at a particular geographic location.

Perennial and Intermittent Streams and Major Springs

A map of perennial and intermittent streams is provided for each AMA. For some AMAs, more than one source of information was used. Stream designations may not accurately reflect current conditions in some cases. Spring data was compiled from a number of sources in an effort to develop as comprehensive a list as possible. Spring data is important to many researchers and to the environmental community due to their importance in maintaining habitat, even from small discharges.

Groundwater Conditions

Several indicators of groundwater conditions are presented for each AMA. Aquifer type can be a general indicator of aquifer storage potential, accessibility of the supply, aquifer productivity, water quality and aquifer flux. Well yield information for large diameter wells is provided and is generally measured when the well is drilled and tested and is reported on completion reports. It was assumed that large diameter wells were drilled to produce a maximum amount of water and, therefore, their reported pump capacities are indicative of the aquifer's potential to yield water to a well. However, many factors can affect well yields including well design, pump size and condition and the age of the well. Reported well yields are only a general indicator of aquifer productivity and specific information is available from well measurements conducted as part of basin investigations. Natural recharge is often one of the least well known component of a water budget. Recharge estimates are generally from hydrologic studies conducted within the AMA.

Water level data are from measured wells, usually collected during the period when the wells were

not actively being pumped or only minimally pumped. Depth to water measurements are shown on mapped wells for the most recent measurement. The basin hydrographs show water-level trends for selected wells, typically over a 30-year period from 1975 to the year of most recent measurement, which varies between AMAs.

The flow directions that are shown generally reflect long-term, regional aquifer flow in the basin and are not meant to depict temporary or local-scale conditions. However, flow directions in some AMAs indicate how localized pumping has altered regional flow patterns.

Groundwater recharge is an important water management program in the AMAs and has had significant effects on groundwater levels at a number of locations. Permit information and the location of underground storage facilities and groundwater savings facilities where CAP water, effluent and surface water are stored for later recovery are shown on maps and tables.

Water Quality

Water quality conditions impact the suitability of water supplies for certain uses. Water providers serving more than 25 people or having 15 or more connections are regulated under the Safe Drinking Water Act and treat water supplies to meet drinking water standards (for more information see www.azdeq.gov). Water quality data were compiled from a variety of sources as described in Volume 1 Section 1.3. The data indicate areas where water quality exceedences have previously occurred, however additional areas of concern may currently exist where water quality samples have not been collected or sample results were not reviewed by the Department (e.g. samples collected in conjunction with the ADEQ Aquifer Protection Permit programs). It is important to note also that the exceedences presented may or may not reflect current aquifer or surface water conditions. Due to a high density of measured sites in the Phoenix, Pinal, Santa Cruz and Tucson AMAs, most sites within 0.75 miles of one another share a common map key. Also shown are contamination sites including DOD, RCRA, Superfund, WQARF, VRP and LUST sites including location, affected media and specific contaminant.

Cultural Water Demand

Cultural water demand, defined in the Atlas as municipal, industrial and agricultural water demand, is an important component of a water budget. Mandatory metering and reporting of water use in the AMAs has resulted in the collection of extensive and relatively accurate demand data. Municipal demand includes water company and domestic (self-supplied) demand estimates. AMA demand information is compiled from several sources in order to prepare as accurate an estimate as possible. Annual demand estimates have been averaged over a specific time period. This provides general trend information without focusing on potentially inaccurate annual demand estimates due to incomplete data or anomalous weather conditions in a single year.

Locations of major cultural water uses are primarily from a 2004 USGS land cover study using older satellite imagery that may not represent recent changes. The cultural demand maps provide only general information about the location of water users.

Effluent generation data were compiled from several sources to provide an estimate of how much of this renewable resource might be available for use. However, effluent reuse is often difficult to

determine both logistically and economically since a potential user may be far from the wastewater treatment plant.

Assured Water Supply

Detailed information on Assured Water Supply (AWS) determinations for subdivisions, master planned communities and service areas are shown on maps and tables. Also shown are Water Adequacy Reports which were issued prior to enactment of the Groundwater Code in 1980. Change of ownership of a previously issued determination is not counted in the totals shown on tables and maps.

Developers of subdivisions within AMAs are required to obtain a determination of whether there is sufficient water of adequate quality available for 100 years and that the development is consistent with the management plan and management goal of the AMA. In addition to these subdivision determinations for which a Certificate of AWS is issued, water providers may apply for assured water supply designations for their entire service area. If a subdivision is to be served water from a designated service area, then a separate Certificate of AWS is not required.

Developers also have the option to obtain an Analysis of AWS, which is generally used to prove that water will be physically available for master planned communities. If an Analysis is issued for groundwater, it reserves a specific volume of water for 10 years for the specific property. (See Appendix A, Volume 1 for more information about the Assured Water Supply Program and Section 8.0-5).

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